POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

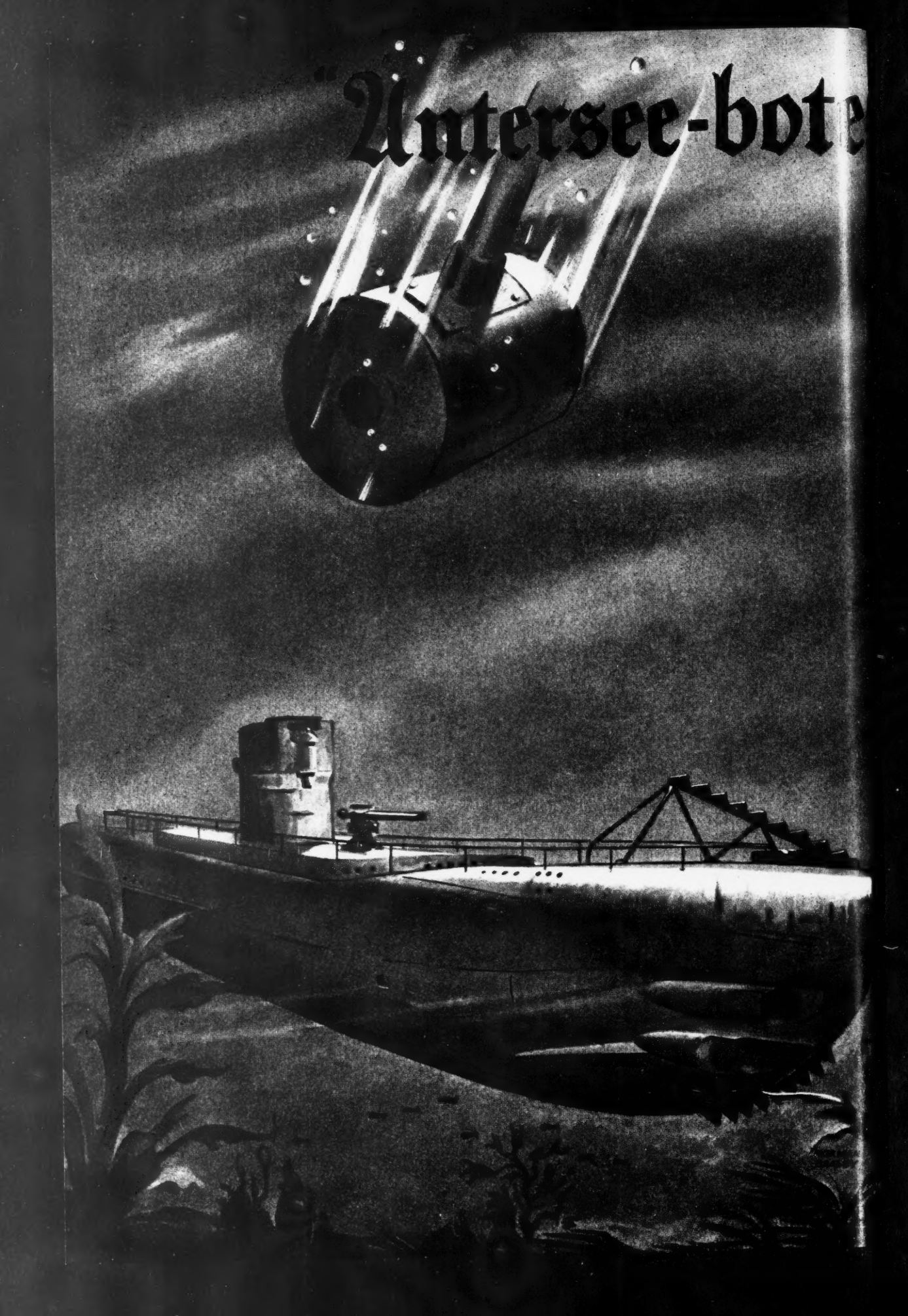
TECHNOLOGY DEPT

Deterioration and Maintenance of Equipment

Converting Furnaces from Oil to Coal

Hotel Heat Economy • Hand Firing a Boiler

New Armature Winding Diagram


Untersee-bote

2

TECHNOLOGY DEPT

277 does not reply"

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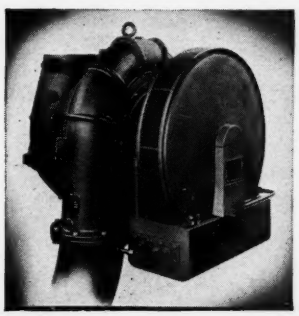
DETROIT

Nor will it reply, Herr U-Bote Admiral. So when hope has died, cross U-277 off the active list. Send out the usual messages of condolence — "For Fuehrer and Fatherland." Try to keep the bad news away from U-Bote circles, for crews tend to become — well, discouraged.

Meanwhile, here in an East coast seaport, another PC boat commander is decorated, his crew feted, and his active little sub-smasher again takes up her patrol job, "Y-guns" and "ash-cans" ready on the instant, listening devices constantly manned, Diesel engines softly purring, their Elliott turbochargers packing added power into every turn of the screw. For the four-cycle Diesels which drive PC boats, minesweepers, and other patrol craft, in a great number of cases enjoy the increased power, speed and economy of supercharging provided by Elliott-Buchi Turbochargers. To say nothing of the Diesel-driven cargo vessels, Army Quartermaster sea-going tugs, tow-boats, etc., many of which are also equipped with these weight-saving, fuel-saving, power-boosting units. Turbochargers are one of Elliott Company's contributions to Victory.



ELLIOTT-BUCHI TURBOCHARGERS are driven by engine exhaust, with no mechanical coupling. Their speed is automatically controlled by the volume of exhaust, hence always adjusted to the load. They increase efficiency in both scavenging and combustion. Used in stationary as well as marine Diesel engine power plants. Full details at your request.

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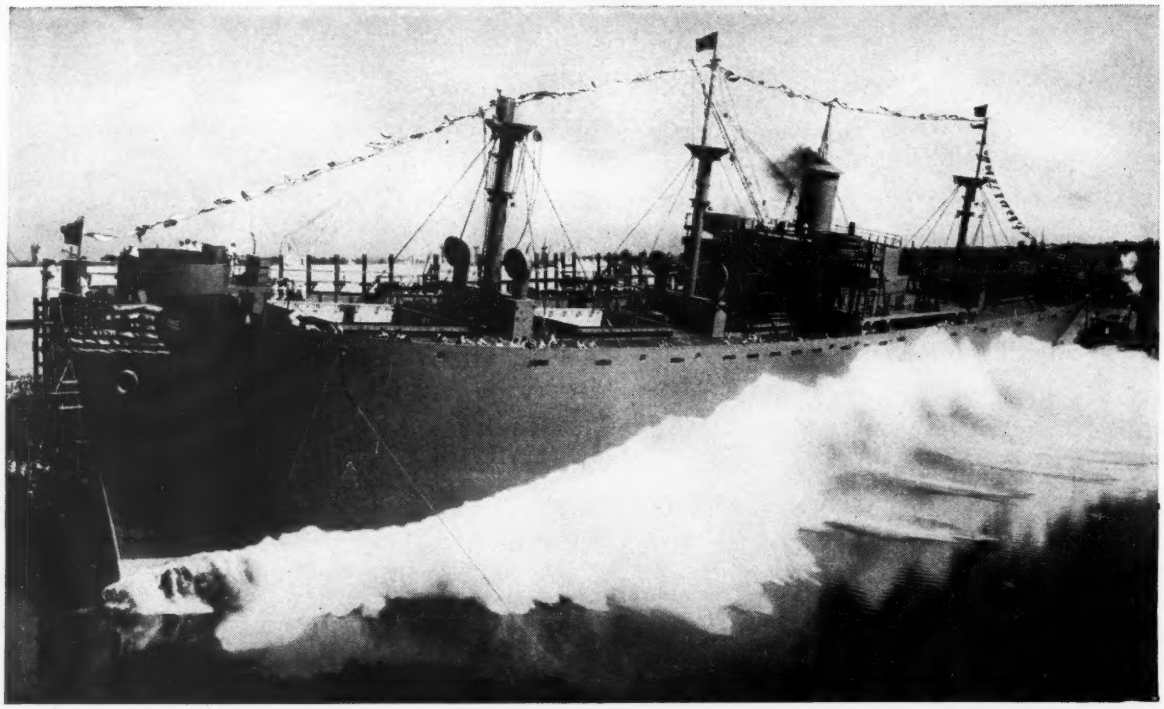
URBOCHARGERS FOR DIESEL ENGINES BY

ELLIOTT

ONE OF AMERICA'S GREAT BUILDERS OF POWER AND PROCESS EQUIPMENT

M-62

LAUNCHED WITH *Steam up!*



SIDE-LAUNCHED with boilers and engines installed, *and with steam up,* this Liberty ship is practically ready to sail. Furnishing power for hundreds of Liberty ships in America's wartime shipbuilding program is a vitally important job of reciprocating engines.

Afloat or ashore . . . whatever the operating temperature or pressure . . . reciprocating steam engines everywhere, both old and new, are maintained at maximum efficiency . . . lubricated with *Texaco Steam Cylinder Oil.*

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FOR EVERY STEAM CONDITION

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Advertising Representatives

CHICAGO: Charles S. Clarke
53 W. Jackson Blvd., Chicago 4, Ill.

NEW YORK: John A. Kershaw
Graybar Bldg., New York 17, N. Y.

PHILADELPHIA: H. G. Wilds
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FULL CAPACITY WITHOUT WASTE OR OUTAGE

Bailey Boiler Control Insures Safe Economical Operation At High Rates of Steaming

★ Full capacity is obtained from a steam generating unit only when the many factors which enter into its operation and control are carefully coordinated and accurately maintained at their optimum values.

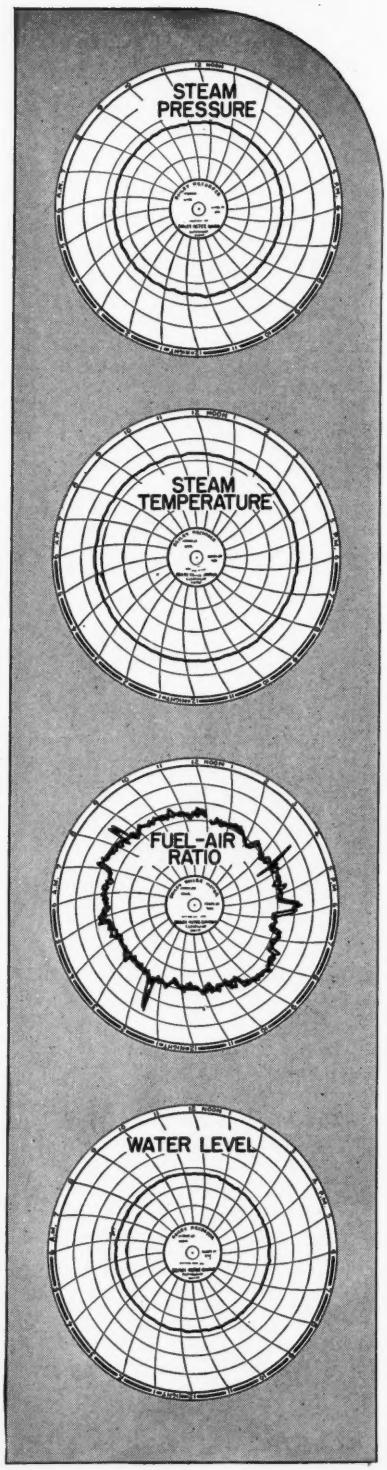
Care must be taken in approaching these optimum values since serious waste and danger of breakdown is likely to occur unless dependable measurements of the factors are made and continuous vigilance is exercised in their control.

Blind efforts to increase boiler capacities by raising combustion efficiency may result in waste of fuel and in serious damage to boiler furnaces.

High capacities may be safely and economically attained with the help of Bailey Boiler Control which continuously maintains the following factors at their optimum values:

1. Steam pressure; to provide maximum turbine efficiency and to prevent waste through safety valves.
2. Steam temperature; to provide maximum turbine efficiency and to prevent damage resulting from excessive temperatures.
3. Fuel—Air Ratio; to keep to a minimum the volume of gases which must be moved through the boiler per unit of heat release, and to reduce excess air loss to a minimum without decreasing fuel economy or damaging furnace refractories.
4. Feed water flow and level; to maintain a uniform heat demand and to avoid both "high" and "low" drum level.

Bailey Meter Control serves the war effort by making it possible for power engineers to carry on with safety and economy at full capacity in spite of wartime scarcities. A-88-1



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BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

FRONT LINES

TO PREVENT deterioration and possible loss of coal stored on docks of the Great Lakes area this summer, Bureau of Mines engineers, in cooperation with dock owners and operators, are working out plans to improve storage methods and effect a substantial saving in necessary wartime fuel for industries of that region. After conferences with several hundred dock operators who handle approximately 50,000,000 tons of coal annually in the Great Lakes traffic, Bureau engineers have prepared technical information treating specific storage problems of the area. This information covers inspection of coal received, handling and piling, reclaiming, temperature observations, and operation and upkeep of the storage area. The technical information was compiled on the basis of data obtained by Arlen Z. Jennings, Senior Engineer, U. S. Bureau of Mines, and applies specifically to the Great Lakes area. Spontaneous combustion is the most common cause of deterioration in stored coal and information on this is vitally needed by the operators. The Great Lakes work is part of the nation-wide campaign by the Solid Fuels Administration for War to encourage buying of coal early and utilizing it wisely under wartime conditions. Since the majority of the coal-using industries in the Great Lakes region draw their coal from the dock storage points as needed, it is recommended that industrial users aid the program by obtaining coal earlier and more frequently than usual and by storing it on their own property. Mr. Jennings has headquarters in the U. S. Court House, Chicago, Ill., and will make available to all dock operators the information referred to on storage problems.

ARMED with a vacuum tube "machine gun" that shoots billions of electronic bullets a second, Dr. Earl A. Gulbransen of the Westinghouse Research Laboratories is investigating the atomic structure of coatings that form on steel, aluminum and copper when these metals are exposed to air or corrosive chemicals. Small amounts of alloy metal can alter the nature of the coating formed on a piston ring, cylinder wall or motor bearing. Iron, for example, acquires a coating of rough iron oxide when exposed to air but when one per cent of chrome is added to the iron the coating formed is chromium oxide, a thin, protective layer that hinders the oxidation of the metal.

GLYCERINE and phthalic anhydride are essential ingredients for the alkyd resin paints used to protect military equipment against weather, salt water, driving sand, rust and hard wear. Estimates received by the Research Committee of the Glycerine Producers' Association show that 42 per cent of the 1943 glycerine production available after fulfilling lend-lease requirements will go into these extra-tough coatings. Next to resins, it is expected that 23 per cent of the 1943 absolute glycerine production, now estimated at about 150,000 lb, will be for this war purpose. Looking forward to post-war demands, however, the Association sees important prospects for glycerine in the food industry.

CONVERSION TO WOOD of products previously manufactured of metal will release to war service more than 5,000,000 tons of metal during 1943. On the average, it is possible to save one ton of steel by the use of 1000 fbm of lumber. Expenditures for construction in 1942 reached an all-time high of $6,170,000,000. The savings of structural steel in roof trusses alone through the use of timber connector construction has been estimated by the Timber Engineering Co. at 400,000 tons. This year, with the emphasis on production, the range of consumer goods in metal that have been estopped or seriously curtailed and have reverted to wood in whole or in part, is surprising: furniture, mechanical refrigerators, caskets and vaults, door and window screens, mirror and picture frames, certain farm implements, beauty shop equipment, children's vehicles, athletic equipment, lawn mowers, slot vending machines, radios, carpet sweepers, weather strip, gutters and downspouts, bottle caps, pocket books, atomizers, bathtubs, jelly molds. Nearly one third of the total 1943 lumber production or 10,500,000,000 fbm, will be used for boxes and crates for military supplies.

IT DETRACTS nothing from the courage and skill of our Flying Fortress gunners to point out that we have given them some superlatively good equipment to work with. Some of this equipment does almost everything to the enemy except conduct funeral services over him. One such device is the Sperry automatic sight with which the 0.50-caliber Flying Fortress guns are now equipped. These guns are mounted in turrets powered by Vickers hydraulic motors. The computing sight automatically makes calculations for fall of the shell, wind deflection and lead, so that the gunner has only to adjust the sight control to correspond with the dimensions of the attacking plane and keep two vertical cross hairs in the sight at the outermost tip of each wing of the target. The hydraulic motors, under very accurate control, enable the gunner to concentrate on his shooting. With their customary genius for underestimating other nations, the Germans completely overlooked the fact that for a long time we have been employing principles of this kind for peaceful rather than warlike purposes. The job of adapting them quickly to the latter was not quite so impossible as it seemed from the stage of the Sportspalast in Berlin.

READERS are urged to investigate the work on burning bituminous coal in domestic heating furnaces that has been done at the University of Illinois by Professor J. R. Fellows and associates. They have developed a new type of downdraft coking furnace for burning bituminous coal with an overall efficiency of 84 per cent. In the process they have also accumulated a great deal of knowledge of the best ways to burn coal in a domestic furnace without any special equipment, by applying fundamental combustion principles. This information is published in a leaflet obtainable from Professor J. R. Fellows, Department of Mechanical Engineering, University of Illinois, Urbana, Ill.

JUST HOW this is going to affect the horsepower of domestic *spiritus frumenti* we don't yet know. But it looks as though some changes are going to be made in the production of this well-known fluid. Conversion of starch to sugar in order to start the fermentation that produces alcohol has required the use of barley malt. This relatively expensive medium is now to be replaced by a substance obtained by treating uncooked wheat with sodium sulphite. Discovery of this process will probably affect also the allied art of baking, for it yields a by-product that will enable bakers to increase the protein content of bread.

RESEARCH men of The B. F. Goodrich Co. have developed a synthetic rubber sponge which will stay soft and compressible at minus 40 F. Of medium density, the new sponge, satisfactory for many wartime as well as peacetime uses, is made in black color and can be furnished in slabs or molded shapes. Goodrich technicians say that, while the task of fabricating ordinary rubber and synthetic non-sponge compounds which will remain flexible at minus 40 F is comparatively simple, it was difficult to develop a sponge compound which would be readily compressible at low temperatures.

POST-WAR automobiles will be small, light-weight editions fueled by high-octane, heavily-taxed gasolines now available only for military aircraft and motorized equipment. Post-war manufacture of 100-plus octane gasolines will force engineers to design Diesel engines which will get the utmost out of low-cetane fuels for railroad, marine, long-distance and overseas air cargo, and construction service. This prediction was made at the recent SAE meeting by Dr. C. M. Larson, chief consulting engineer, Sinclair Refining Co. He reported that high-octane aviation gasolines, explosives, synthetic rubbers, plastics, anaesthetics, and other essential war products now are being made in petroleum refineries at the expense of the kerosenes and distillates from which Diesel fuels are derived. He expressed the opinion that Diesel fuels will be on the critical list by 1944 and said that even after the war the extremes between octanes for gasoline engines and cetanes for Diesel engines will broaden in favor of high octanes to the detriment of Diesel fuel ignition quality. He warned that the current demand for distillate fuels by the armed forces, particularly the Navy, will reduce the potential of Diesel fuels and heating oils. Blame for wear and fouling of Diesel engines was shifted from lubricants to unsatisfactory fuels by G. H. Cloud and A. J. Blackwood, of Standard Oil Development Co. Sulfur content was held the most important. (See also page 110, May 1943 issue).

REPRESENTATIVES of private and public electric utilities from various sections of the country met last month with J. A. Krug, Director, Office of War Utilities, and members of his staff to discuss various conservation measures the industry may be asked to put into effect. The discussion centered around a voluntary conservation program, which, it was agreed, might achieve the conservation objectives as well or better than a mandatory savings program to eliminate non-essential uses of electricity, without the difficulties which the latter entails.

DIFFICULTIES of keeping the Nation and its armed forces supplied with coal and oil accentuate the importance of the large block of hydroelectric energy being generated for war purposes in the 30 Bureau of Reclamation power plants in the West, says Secretary of the Interior Harold L. Ickes. The Bureau has 93 generators in 11 states, with a rated capacity of about 1,850,000 kw. To produce by steam the 12,000,000,000 kw-hr of energy that will be generated at Bureau powerhouses this year, would have required 7,860,000 tons of bituminous coal or 1,350,000,000 gal of fuel oil. To haul the coal would require 196,000 railroad cars (a train more than 1950 miles long) for oil, more than 135,000 tank cars (a train 1350 miles long). The manpower saved is also significant.

IN STERN WORDS, the anti-strike bill recently passed by Congress over the President's veto provides severe penalties for those who instigate, direct, or aid a strike. But how can this cause palpitations in the breast of John L. Lewis? Technically, he has given nobody any orders to strike; he has simply refused on occasion to give orders to work. At the time the bill passed, thousands of miners were defying Lewis' latest order that they return to work. Does the bill correct that situation? The bill deliberately by-passes union leadership by making it impossible for labor leaders to honor their no-strike pledge. It gives congressional sanction to strikes in non-government plants, provided congressional procedure is followed. In short, the bill is a fake and a bluff. The Senate, says K. M. Landis II, wanted a bill with teeth in it even if the teeth were false.

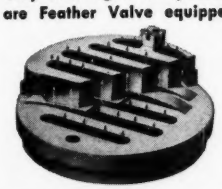
ADVANTAGES that hard chromium give to steel are now possible for aluminum, says Colonial Alloys Co. Plating thicknesses have been made up to 0.050 in. without hydrogen embrittlement, crazing or lifting. The application applies to all forms of aluminum and aluminum alloys, including all the cast, forged and wrought forms. Adhesion tests of the plate to the aluminum have been checked to be at least 16,000 psi. Thermal resistance has been tested satisfactorily by heating the specimens up to about 1000 F and then plunging them into ice cold water or calcium chloride (temperature 50 F) without separation or lifting of plate.

PRODUCTION of magnesium metal at the newly erected magnesium-chlorine plant in Louisiana has begun, according to an announcement by the Mathieson Alkali Works, Inc., the operating company. The plant is owned by the Defense Plant Corporation and has a future capacity of more than 50,000,000 lb of magnesium metal a year. The principal raw material is dolomitic stone, a rock resembling limestone and consisting of calcium and magnesium carbonates, which is shipped from nearby quarries. This ore is calcined, locally produced natural gas being used for the purpose. The resulting oxides of calcium and magnesium are treated with calcium chloride, a product of the process by which soda ash is made at the parent Mathieson plant in Louisiana. The mass is then treated with carbon dioxide obtained from the calcination of the dolomite, which converts the calcium into insoluble carbonate, leaving magnesium chloride. This product, after being concentrated, is electrolyzed, forming magnesium and chlorine.

75 TO 3000 HORSEPOWER

HORIZONTAL DUPLEX MOTOR DRIVEN DIRECT CONNECTED AND BELTED

*** Only Worthington Compressors are Feather Valve equipped**



Simplest . . . lightest . . . most efficient valve yet devised for compressor service.

- Each valve consists of light strips of steel whose easy flexing permits passage of air
- No cushioning device required
- Strips seat by contact . . . not impact
- Unusually tight . . . due to flexibility of strips
- Minimum air friction . . . result, minimum power consumption due to flexibility, large lift area and tight seating
- Maximum accessibility . . . removable in five minutes . . . replaceable in eight
- Intake and discharge valves complete are interchangeable
- Negligible maintenance . . . nominal expense for valve strip renewal at long intervals

* Reg. U. S. Pat. Off.

Thousands of horsepower of Worthington compressors are now carrying vital parts of the United Nations' war production load.

Among the most important of their many noteworthy features is their FEATHER VALVE equipment . . . giving high volumetric efficiency and smooth, quiet operation, and contributing largely to the remarkable dependability, negligible maintenance and long operating life reported by prominent users in every field and under the most exacting conditions.

Both the Navy E and Army-Navy E Awards have been presented to Worthington for speed and excellence in production.

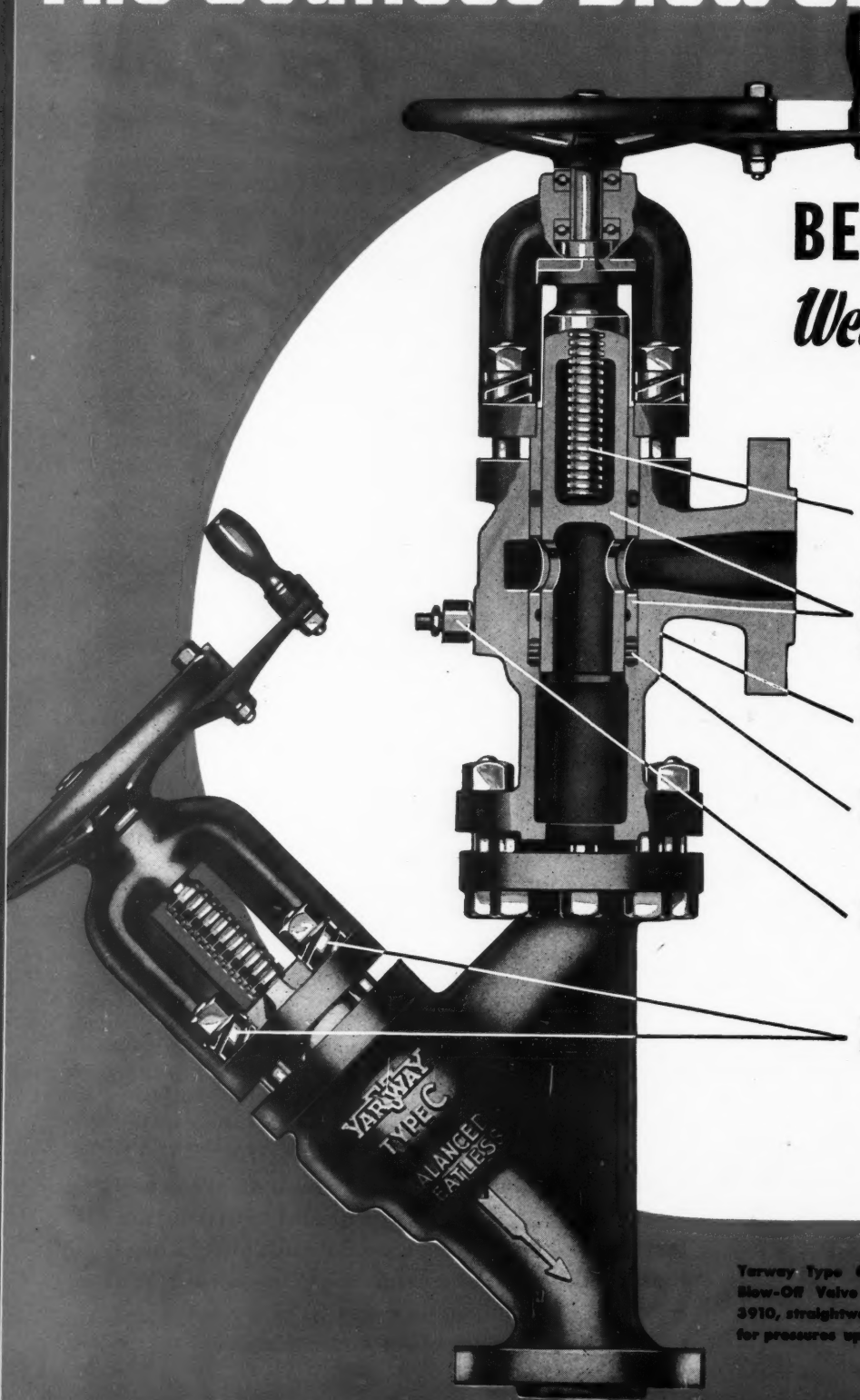
AC3-4

WORTHINGTON PUMP AND MACHINERY CORPORATION • HARRISON, NEW JERSEY

The Seatless Blow-Off Valve

BECAUSE ★ ★ ★

Wear and Clog with



Heat-treated steel stem.

Nitralloy Plunger and lower Follower Gland. Brinell hardness 1100 (upper Follower Gland, chromium plated steel).

Cast Steel Body and Yoke.

Laminated packing ring with stainless steel reinforcing inserts.

Alemite lubrication of Plunger (also for ball thrust bearings in yoke).

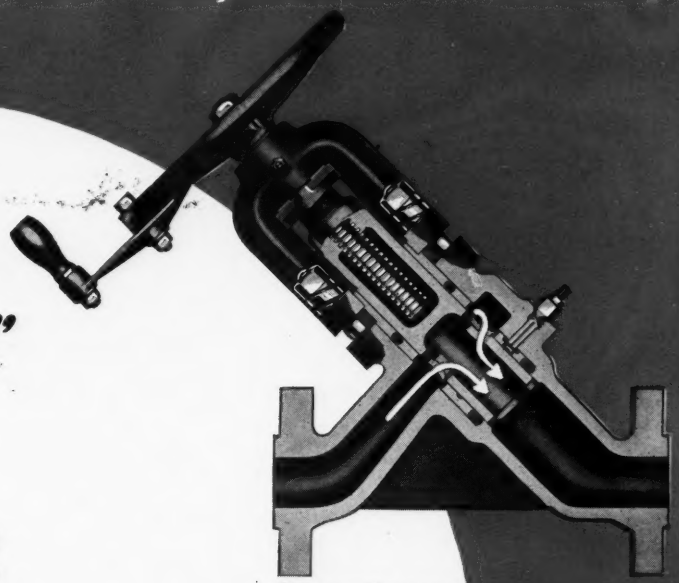
Yoke Springs maintain required pressure on packing at all times.

Yarway Type C Seatless Tandem Blow-Off Valve (angle valve Fig. 3910, straightway valve Fig. 3912) for pressures up to 600 lbs.

YARWAY

"Standard" in Over 12,000 Plants

"No Seat to *Score, Mud, Scale and Dirt*"

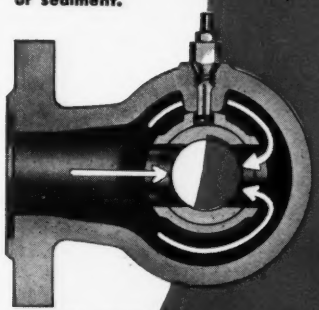


Note ample space for free flow with no projections or pockets to accumulate scale or sediment.

More than a quarter century ago, Yarway introduced their Seatless Blow-Off Valve and said—"No seat to score, wear and clog with mud, scale and dirt." Power plant operators, harassed by continuous trouble and expense with conventional valves—welcomed the Yarway as the answer to their troubles . . . purchased them, watched them, standardized upon them. And the Yarway Seatless design, in a relatively short time, became the most widely preferred blow-off valve.

Today, after a quarter century of service, it still holds that distinction. Sound fundamental design...coupled with continuous mechanical and metallurgical research anticipating ever-new service requirements . . . makes the highly improved Yarway Seatless Valve of today just as good insurance against blow-down trouble and expense in today's plants as it was in the plants of twenty-five years ago.

There is a Yarway Valve for every pressure and purpose. Write for Catalog B-422 for pressures up to 400 lbs. Catalog B-431 for higher pressures.

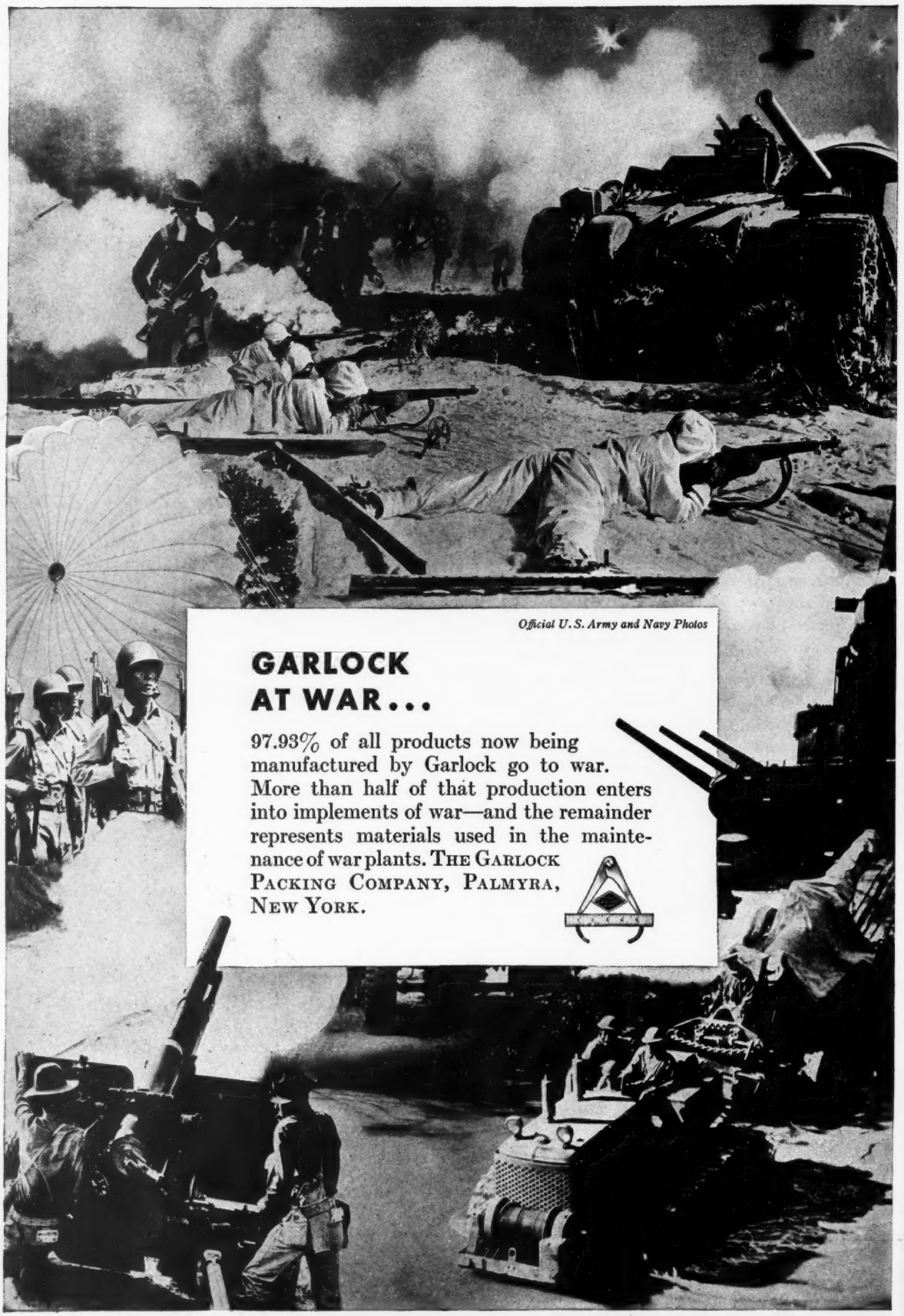


Pressure surrounds plunger making a fully balanced valve, easy to operate regardless of pressure.

Nitralloy plunger and lower follower gland, and laminated packing with stainless steel inserts, add years to valve life.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

BLOW-OFF VALVES



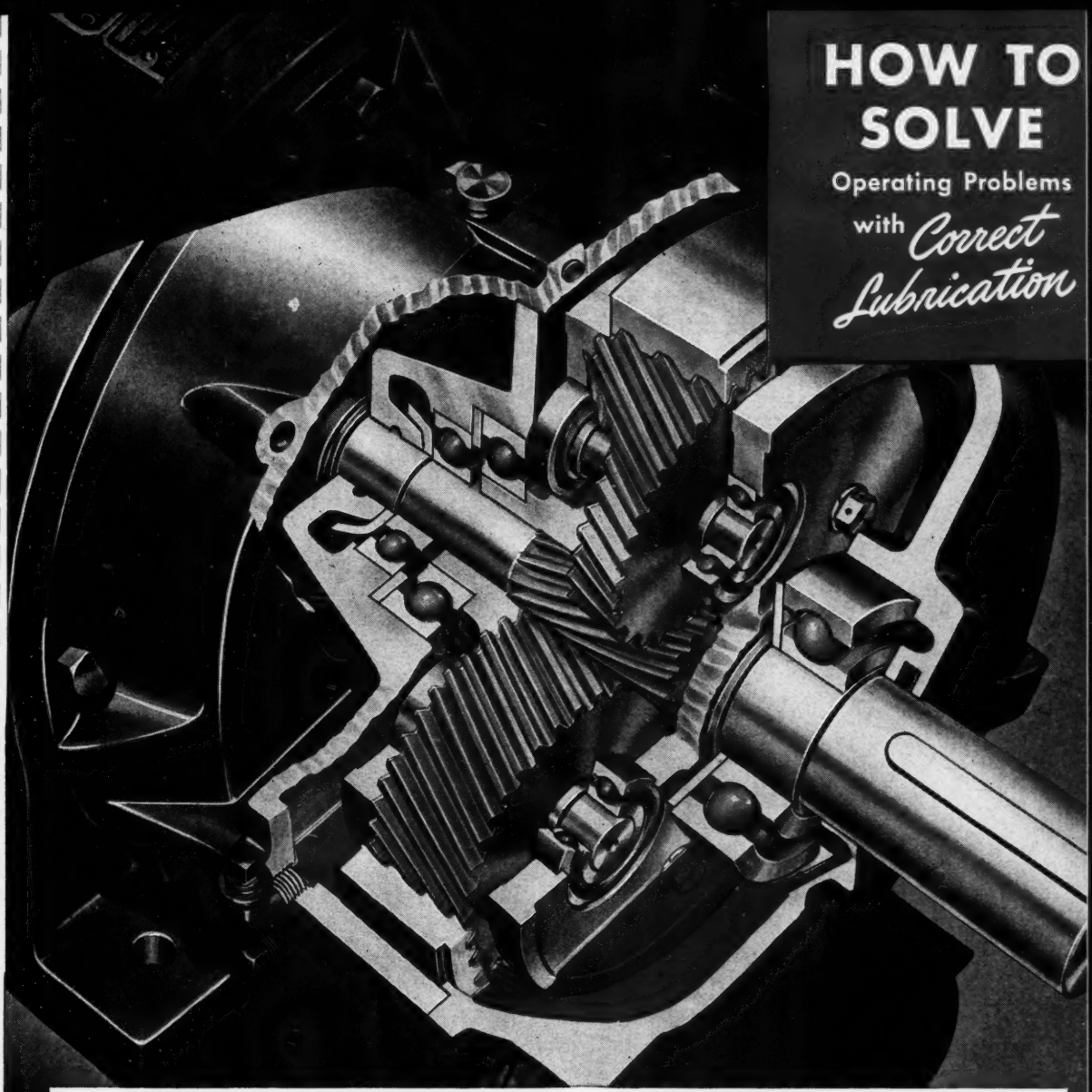
Official U. S. Army and Navy Photos

GARLOCK AT WAR...

97.93% of all products now being manufactured by Garlock go to war. More than half of that production enters into implements of war—and the remainder represents materials used in the maintenance of war plants. THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK.

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION



HOW TO SOLVE

Operating Problems with *Correct Lubrication*

Prepare them for 3 Shifts!

WHEN YOU CHANGED from one shift to three, you began crowding *3 years of wear* into one calendar year of operation!

You've got to *condition* your machines for full-time operation. You can't expect them to stand the gaff with "good enough" lubricants.

On such important production units as geared motors make sure you are using a Gargoyle Vacuoline Oil.

This member of the famous Gargoyle "family" has the chemical stability to stand up under "round-the-clock" operation. This means...freedom from emulsions and sludge...long oil life...and long, trouble-free gear life, too!

In fact, Gargoyle Vacuoline Oil is ideal for enclosed circulation-oiled and splash-oiled gears. Forty-eight hours a week—or 168 hours—this oil will provide dependable lubrication.

GARGOYLE Lubricants

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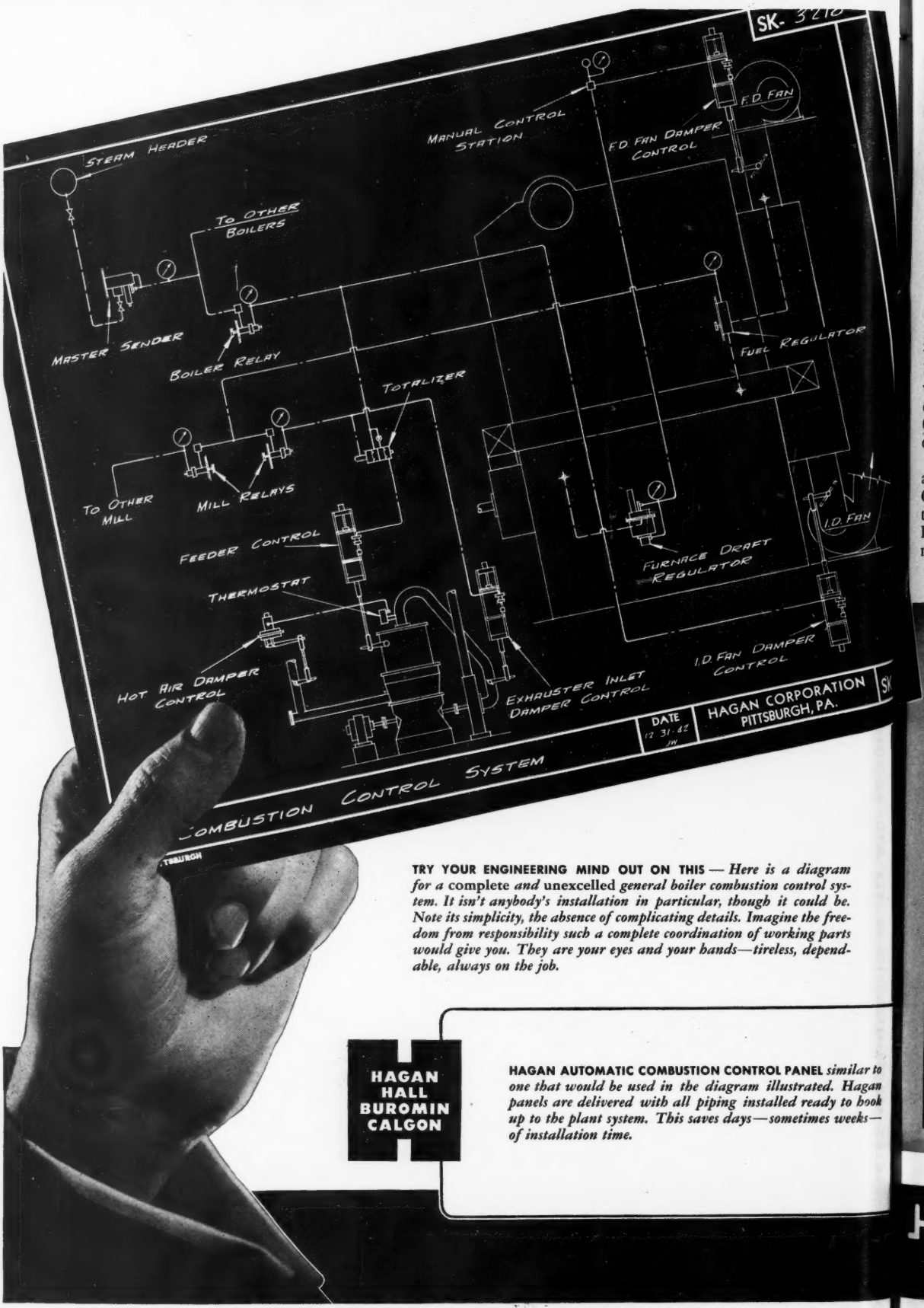
CALL IN SOCONY-VACUUM



TRY YOUR ENGINEERING MIND OUT ON THIS — *Here is a diagram for a* complete *and* unexcelled *general boiler combustion control system. It isn't anybody's installation in particular, though it could be. Note its simplicity, the absence of complicating details. Imagine the freedom from responsibility such a complete coordination of working parts would give you. They are your eyes and your hands—tireless, dependable, always on the job.*

HAGAN
HALL
BUROMIN
CALGON

HAGAN AUTOMATIC COMBUSTION CONTROL PANEL *similar to one that would be used in the diagram illustrated. Hagan panels are delivered with all piping installed ready to hook up to the plant system. This saves days—sometimes weeks—of installation time.*

Blueprint to successful boiler operation

WHILE the design for a Hagan Automatic Combustion Control installation reproduced here is probably quite different from one which would meet the needs of your boilers, its essential characteristics would be the same. For they are the characteristics which make all Hagan Control equipment distinctive. For example:

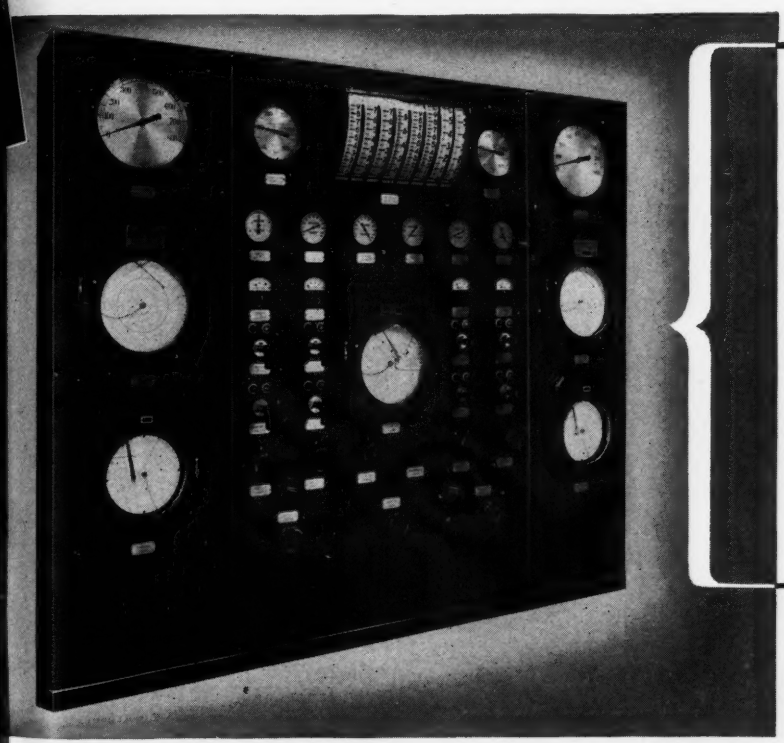
All Hagan Control Systems are alike in their operating simplicity. Ordinary help can easily take care of the largest or smallest installation. Hagan Control is so completely automatic it will operate dependably on its own with little or no supervision.

There would be no installation difficulty on old or new boilers. Hagan Control is so complete when it reaches you that it can be quickly installed without difficulty and in most cases without shutting down the boiler.

Built-in ruggedness has always been a Hagan feature in any of its equipment. Once installed you can look forward to years of uninterrupted trouble-free service.

For other important operating advantages which are definitely Hagan characteristics, you can count on — exceeding sensitivity to load conditions; accuracy of adjustments for small variations; speed of movement, with stability, throughout operating range; flexibility in meeting individual plant conditions. These are products of the engineering minds who pioneered in automatic combustion control and have consistently set the pace for this type of equipment.

Couple these facts with the five maximums promised by Hagan in the accompanying box and you will have the answer to Hagan leadership. Full details on request.



HAGAN CONTROL ASSURES

★ **MAXIMUM** quantity of steam from any given plant, by introducing fuel and air in correct proportion for utmost efficiency.

★ **MAXIMUM** utilization value, uniform steam pressure and temperature, in accordance with demand.

★ **MAXIMUM** output from boilers of differing capacities, automatically.

★ **MAXIMUM** steam for production, by reducing loss of steam in frequent soot blowing.

★ **MAXIMUM** protection of auxiliary equipment, fans, stokers, etc. by maintenance of uniform operating conditions.

HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

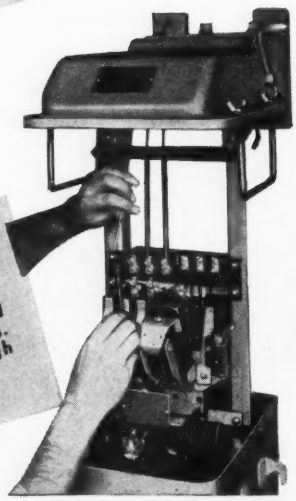
GENERAL ELECTRIC RECOMMENDS

Combination Starters

Instead of Separately Mounted Motor-circuit Switches and Starters

Dust-tight Combinations. For extremely dusty locations. Available through NEMA Size 5.

General-purpose Type. For indoor installations where atmospheric conditions are normal. Available through NEMA Size 5.



For Corrosive Locations. Oil-immersed. Two forms—for both corrosive and hazardous locations. Available through NEMA Size 5.

New High-voltage Combination. Recently developed—provides split-cycle, short-circuit protection and starting means for 2300- and 4000-volt motors.

COMBINATION STARTERS for motors from 1 to 1000 hp

ecause . . . they save vital materials

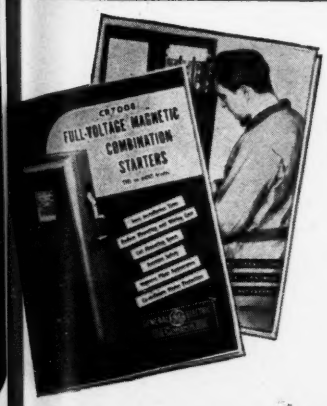
● By buying both the motor-circuit switch and the magnetic starter as one compact unit, you save the copper wire, steel conduit, and fittings that are necessary for installing two separately mounted devices—plus the saving gained by using only one steel enclosure instead of the two individual cases required for separate controls.

ecause . . . they can be installed easily by "green" crews

● G-E combination starters eliminate one complete mounting job on every installation—a time saving of up to 50 per cent. They are completely wired at factory, so all you need do is to connect power, motor, and control leads—saving up to 40 per cent in wiring time.

ecause . . . they reduce costly accidents

● Combining the motor-circuit switch in the same case with the magnetic starter makes it possible to mechanically interlock the switch with the door so that the door cannot be opened while the power is on. (With separate devices, there is nothing to prevent the operator from opening a case on a "live" starter.)



Write for these Bulletins

CR7008 FULL-VOLTAGE MAGNETIC COMBINATION STARTERS —BULLETIN GEA-3715

NEW SIMPLIFIED GUIDE TO THE SELECTION AND APPLICATION OF COMMONLY USED MOTOR CONTROL —BULLETIN GEA-4015

General Electric Company, Section D 676-94 Schenectady, N. Y.

Please send me the publications checked below.

☐ **COMBINATION STARTERS—GEA-3715**

☐ **SIMPLIFIED GUIDE—GEA-4015**

Name .....

Company .....

Address .....

City ..... *State* .....

9020

GENERAL ELECTRIC

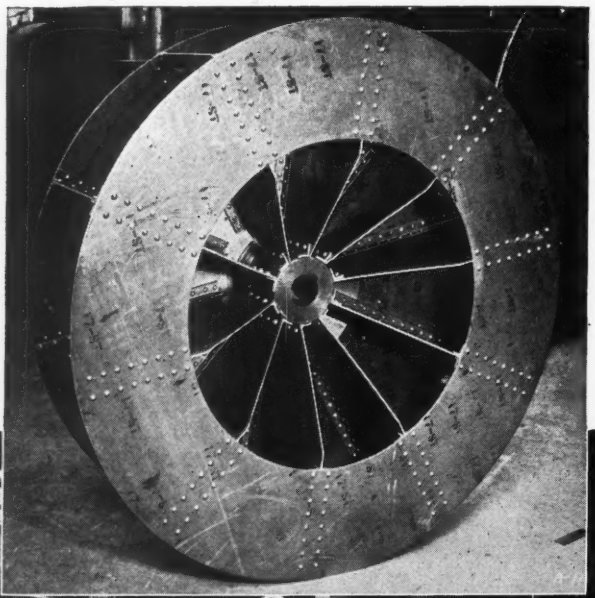
Progress and Power in the

Food for the guns, warheads for torpedoes, explosives for mines, bombs, grenades and mortar shells—on them our armed forces depend for Victory. They are our assurance of Liberty in a free world.

We, at American Blower, are proud of our privilege to contribute muscles, machines and brains to the manufacture of vital equipment for America's giant Ammunition Industry. Every facility we own is today in service for Victory.

In the ammunition factories themselves and in the public utilities plants which feed them vital power, Mechanical Draft equipment and Fluid Drives built by American Blower are directly and indirectly playing an important part in the war effort.

We have but one pledge—one purpose: To produce more and more so that the Axis powers of evil may perish from the Earth.



AMERICAN BLOWER

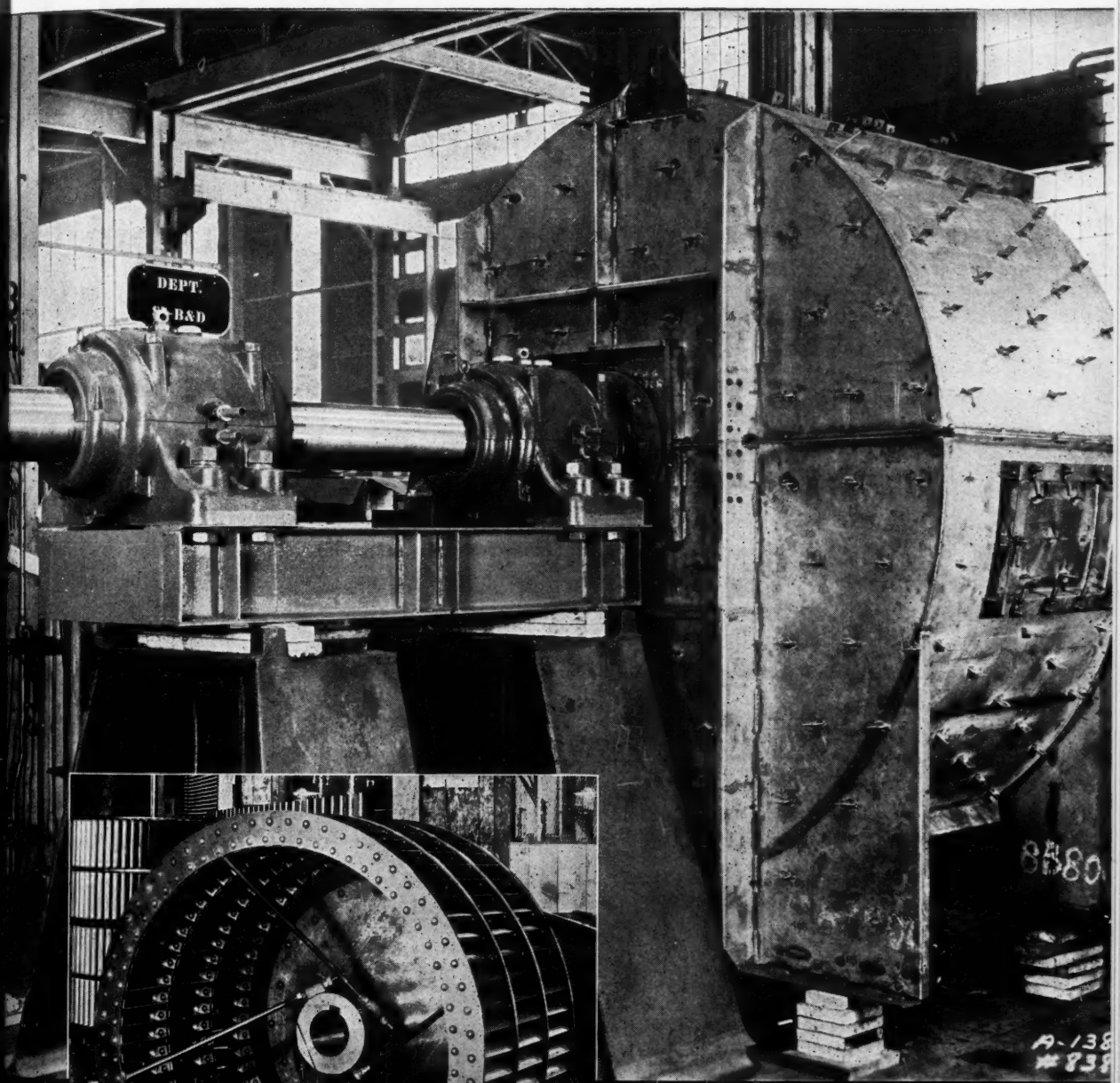
AMERICAN BLOWER CORPORATION, DETROIT, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.

Division of AMERICAN Radiator and Standard Sanitary Corporation

ARMY E NAVY
For excellence in production.

Radial Blade H.E. Blowers with spark-proof wheels for circulating explosive fumes in the manufacture of smokeless powder. Left, above, is a spark-proof wheel showing interior construction. Where men's lives may depend upon it, American Blower apparatus is a safe choice.

AMMUNITION INDUSTRY



Heavy Duty Sirocco Fan constructed throughout of stainless steel for circulating radiant and corrosive gases in the manufacture of SYNTHETIC TOLUENE. Insert (at left) shows construction of the Taper Bored Sirocco wheel used in this fan.

76% OVERALL EFFICIENCY

with "Jittery" Load

Without Heat Recovery Equipment

THIS MONTH'S report on Taylor Stokers comes from a company whose products are fighting on every front. They obtain an overall efficiency of 75 to 76% with a rapidly fluctuating steam hammer load and without heat recovery equipment.

The Taylor Stokers responsible for this performance are power dump stokers, designed to deliver 67,000 lbs. of steam per hour at 175 lbs. gauge, 377°F. steam temperature. These units, installed in 1942, burn West Virginia and Ohio coals.

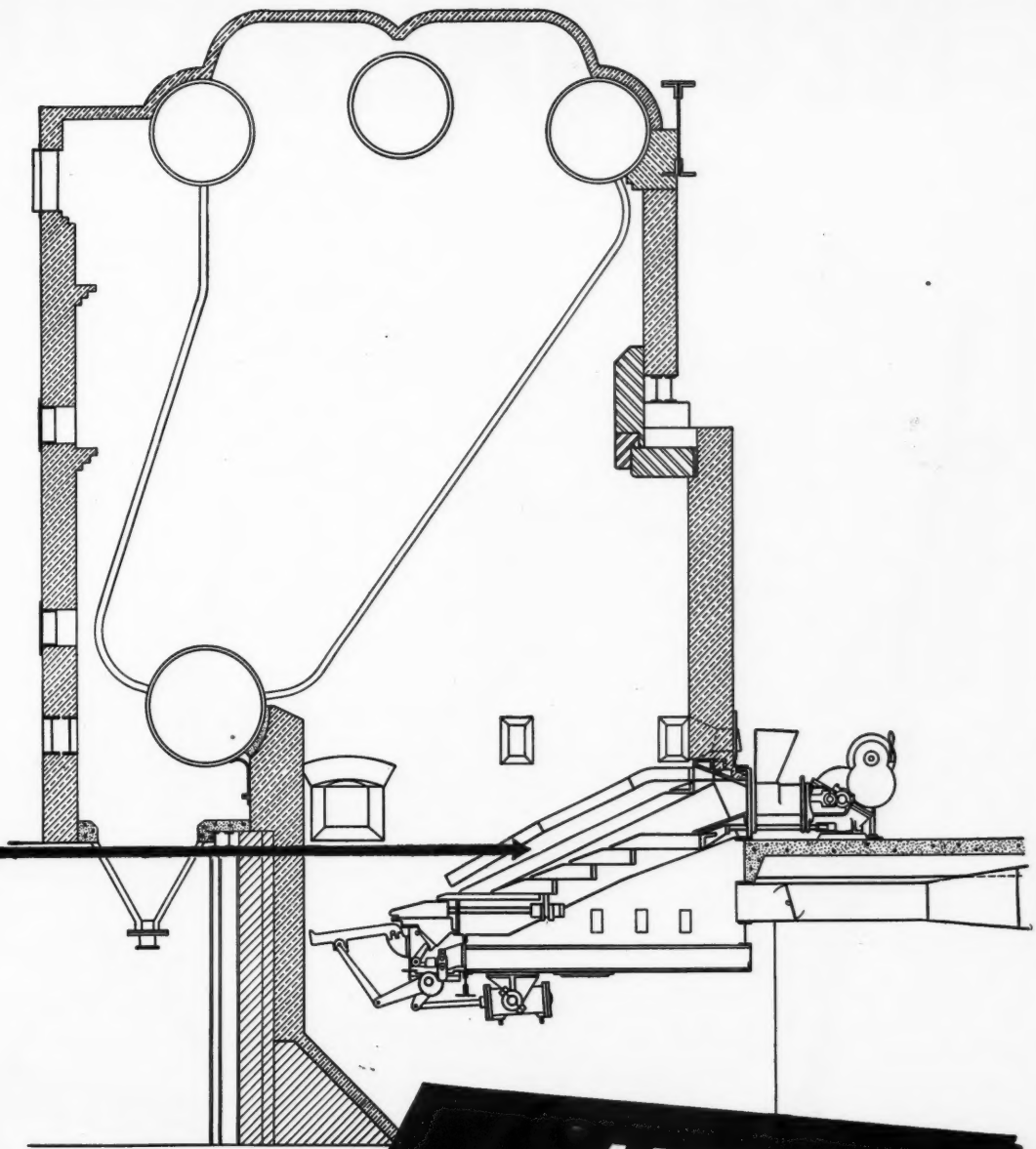
The company operates 8 other Taylor Stokers and has been a consistent purchaser since 1925. Only one conclusion can be drawn from this continued preference.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. **RELIABILITY**— the ability to operate with minimum outage and minimum standby equipment.
2. **CAPACITY**— the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.
3. **MAINTENANCE**— the ability to operate continuously with minimum repair costs.
4. **FLEXIBILITY**— the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.
5. **EFFICIENCY**— the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.
6. **OPERATION**— the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.
7. **ADAPTABILITY**— the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.
8. **FUEL FLEXIBILITY**— the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.
9. **REFUSE DISPOSAL**— the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.
10. **STACK DISCHARGE**— the practical elimination of "smoke nuisance" without special equipment.
11. **SPACE REQUIREMENTS**— the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.
12. **OBSOLESCENCE** — the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

AMERICAN ENGINEERING

PHILADELPHIA • PENNSYLVANIA



A-E-CO TAYLOR STOKERS
LO-HED HOISTS
HELE-SHAW FLUID POWER
MARINE DECK AUXILIARIES

A-E-CO
TAYLOR STOKER

COMPANY

AE CO 75th ANNIVERSARY

*NEUTRALIZATION N

DEFINITION: The neutralization number is the weight in milligrams of the amount of potassium hydroxide (KOH) required to neutralize the acid constituents in one gram of oil.

NEUTRALIZATION TEST: Following a carefully prescribed procedure, a definite quantity of oil together with a mixture consisting of equal parts distilled water and alcohol are agitated thoroughly and heated to boiling. A phenolphthalein indicator is added and a solution of aqueous potassium hydroxide of definite strength is poured into the mixture in small increments and shaken vigorously each time. The first appearance of a sharp pink color throughout the alcohol water layer indicates the point of complete neutralization.

The number of milligrams of potassium hydroxide per gram of oil required to achieve this result is called the Neutralization Number.

SIGNIFICANCE: Corrosive mineral acids are sometimes used during the refining process of certain crudes. As a precaution against their presence in harmful proportions, it is customary to specify a maximum Neutralization Number of 0.10 for clear colored, straight mineral lubricating oils.

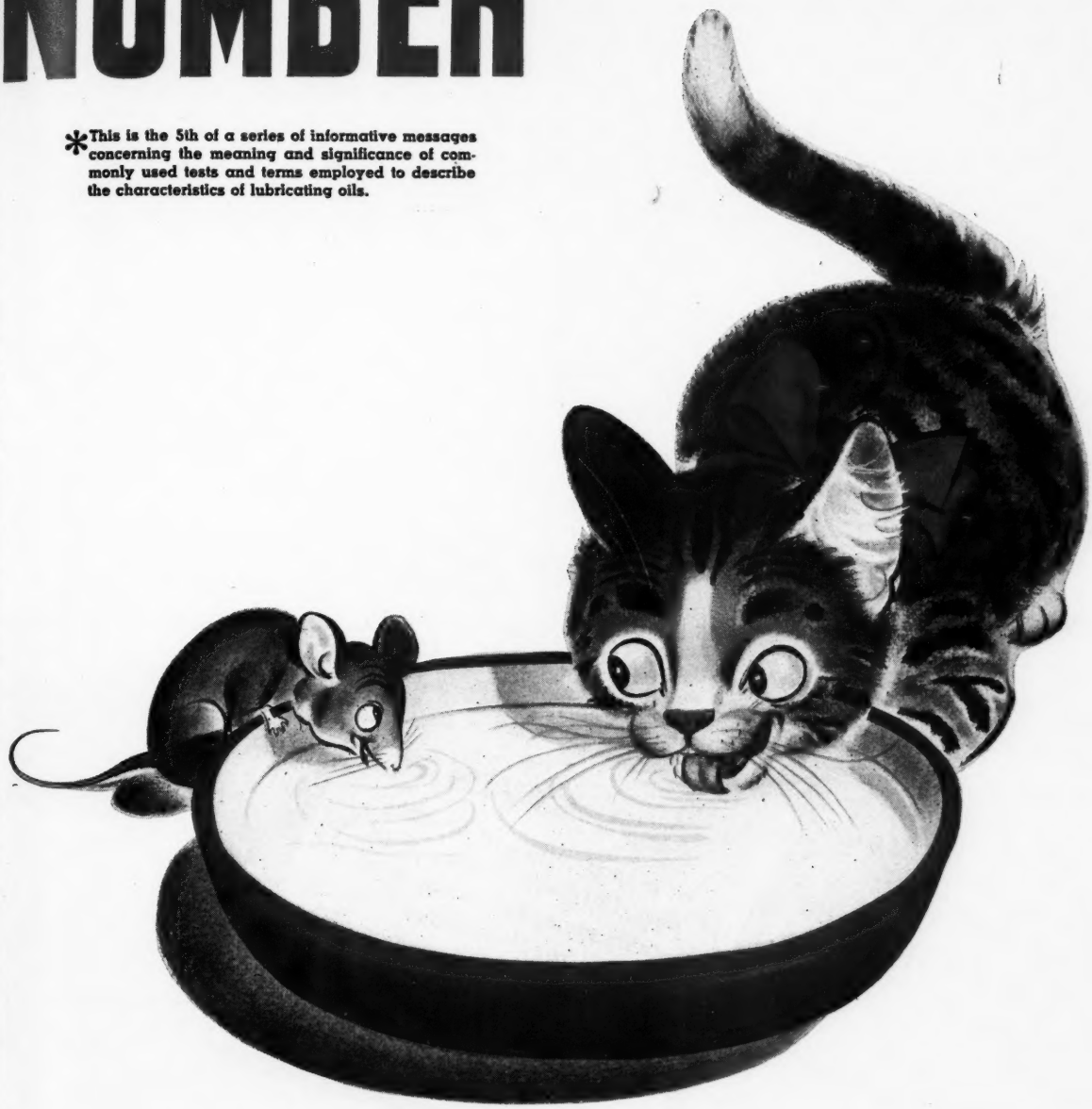
The Neutralization Number has no such significance in connection with unfiltered cylinder oils and black oils. These may contain larger amounts of harmless organic acids originating in the crude petroleum. High Neutralization Numbers do not imply corrosive acidity with compounded oils; i.e. mixtures of mineral oils and fatty oils. The latter oils are often inherently high in organic acidity.

DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.

SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE **TYCOL**

NUMBER

*This is the 5th of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.



Tycol lubricants are manufactured in a comprehensive line so as to meet every specific operating requirement. Whether straight mineral or compounded, they are produced under rigid control to assure freedom from all harmful acidity.

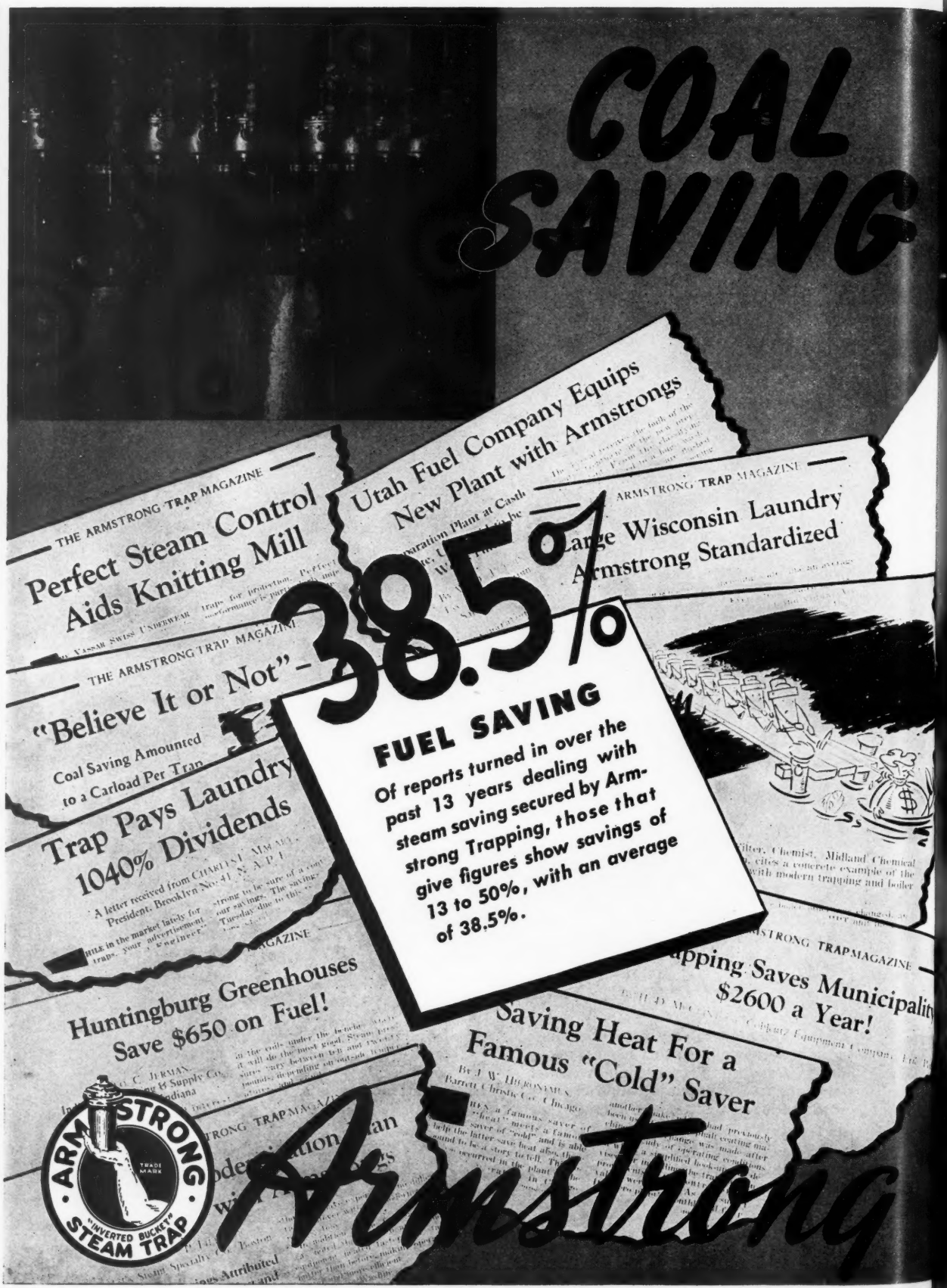
Tide Water Engineers will recommend the Tycol lubricant best suited to your particular requirements.

TIDE WATER ASSOCIATED OIL COMPANY

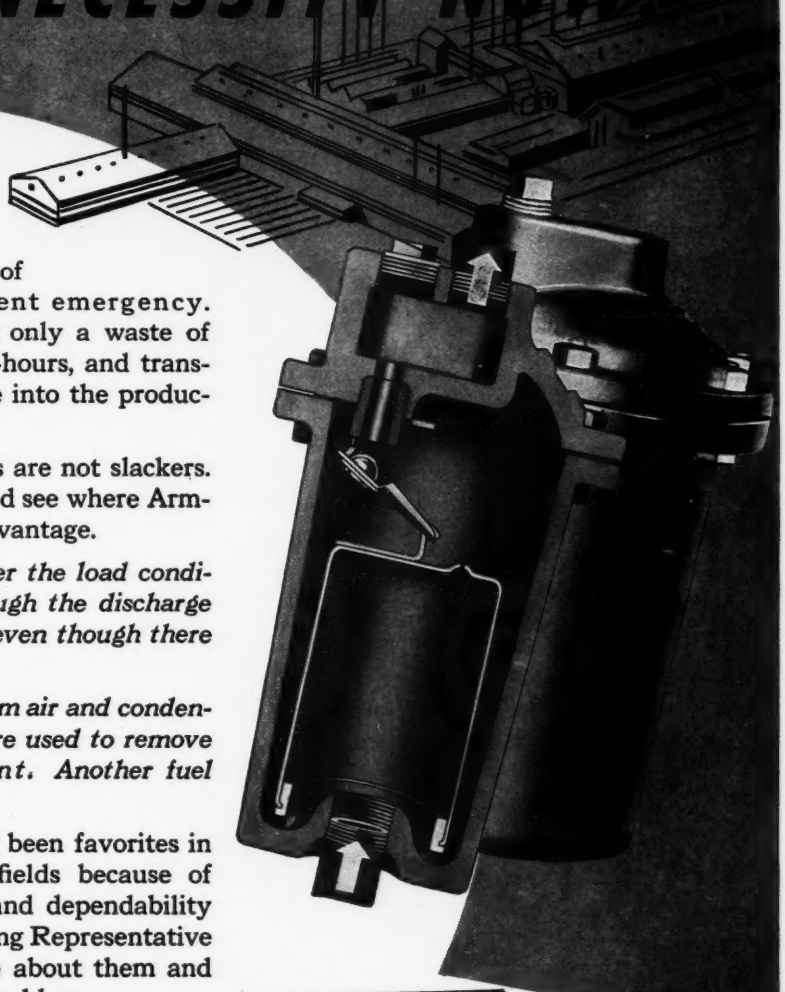
Eastern Division: 17 Battery Place, New York 4, N. Y. • *Principal Branch Offices:* Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL

INDUSTRIAL LUBRICANTS


COAL SAVING
THE ARMSTRONG TRAP MAGAZINE
Perfect Steam Control Aids Knitting Mill
Utah Fuel Company Equips New Plant with Armstrongs
THE ARMSTRONG TRAP MAGAZINE
"Believe It or Not"
Coal Saving Amounted to a Carload Per Trap
38.5%
FUEL SAVING
Of reports turned in over the past 13 years dealing with steam saving secured by Armstrong Trapping, those that give figures show savings of 13 to 50%, with an average of 38.5%.
ARMSTRONG TRAP MAGAZINE
Large Wisconsin Laundry Armstrong Standardized
Trap Pays Laundry 1040% Dividends
Huntingburg Greenhouses Save $650 on Fuel!
Saving Heat For a Famous "Cold" Saver
Armstrong
ARMSTRONG
TRADE MARK
"INVERTED BUCKET"
STEAM TRAP

highly important in the past—
A VITAL NECESSITY NOW!



CONSERVATION of coal through steam saving is of vital necessity in the present emergency. Wasted steam represents not only a waste of resources, but of money, man-hours, and transportation miles that have gone into the production and distribution of coal.

Make sure your steam lines are not slackers. Check over your equipment and see where Armstrong traps can be used to advantage.

NO STEAM LOSS— *Whatever the load condition, no steam can pass through the discharge orifice of an Armstrong trap, even though there is no condensate load.*

NO PRODUCTION LOSS *from air and condensate, when Armstrong traps are used to remove them from process equipment. Another fuel saving!*

Armstrong traps have long been favorites in power, heating and process fields because of their simplicity, efficiency and dependability over long periods. An Armstrong Representative will be glad to tell you more about them and help you with your trapping problems.

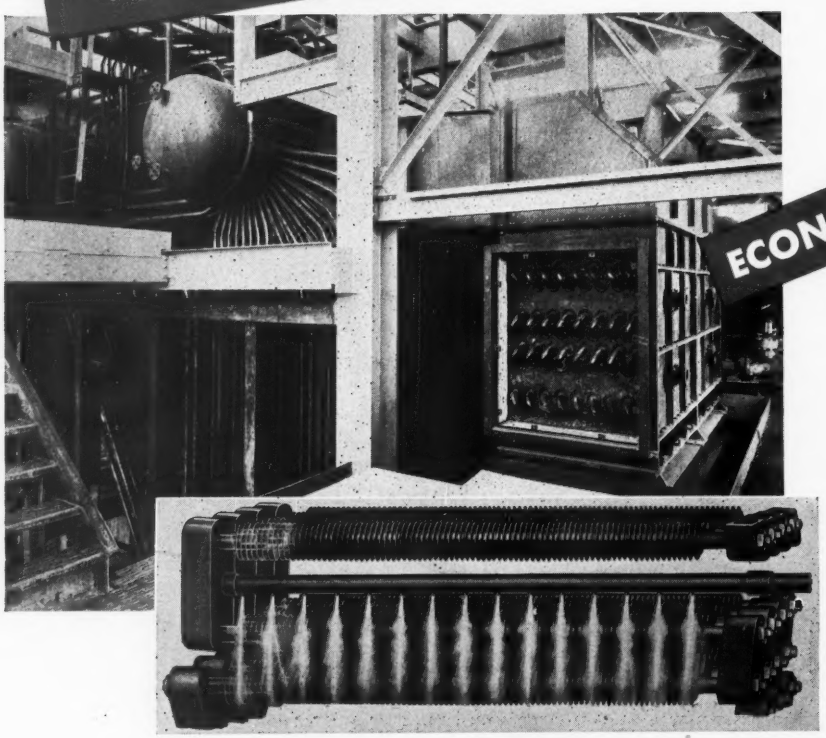
ARMSTRONG MACHINE WORKS
810 Maple Street • Three Rivers, Michigan

Write for the Armstrong Catalog, and the new Service Guide showing plant maintenance men how to get the most out of steam traps.

SILLY- ISN'T IT!
BUT IT'S JUST AS SILLY TO HAVE TRAPS THAT LEAK STEAM, OR NO TRAPS AT ALL
HEY-MAN DON'T DO THAT!
BOILO BOILER
BOILO BOILER

STEAM TRAPS

3 WAYS TO INCREASE BOILER CAPACITY



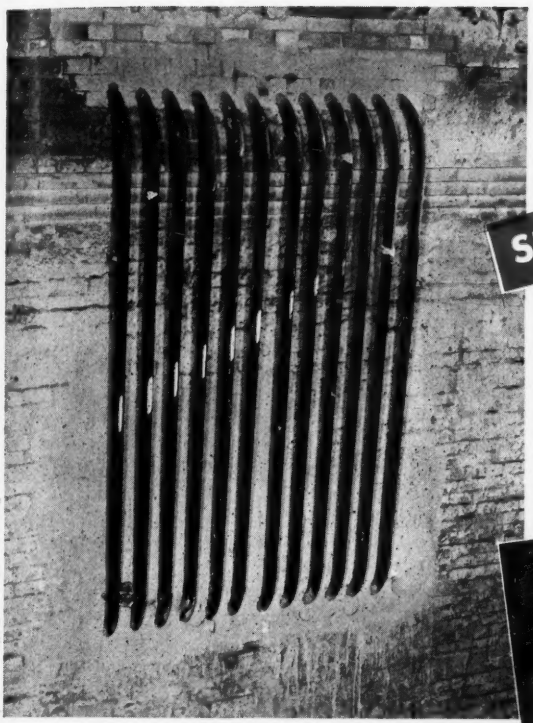
ECONOMIZERS

Typical economizer showing extended surface construction.

More than 4500 Foster Wheeler extended surface economizers have been designed, built and constructed during the past 23 years for all types of steam generators ... from H.R.T. boilers at 100 lb. pressure to 750,000 lb. per hr. steam generators operating at 1600 lb. pressure. Steam capacities have been increased an average of 10% with the addition of economizers to existing units.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK, N. Y.

FOSTER



SUPERHEATERS

Convection and radiant superheaters installed in existing boilers increase heat output, reduce steam consumption of prime movers, and decrease condensation losses in long steam lines. Separately fired types also available. Each Foster Wheeler superheater incorporates the engineering experience of more than 16,000 superheater installations constructed during forty years.

WATERWALLS

Furnace waterwalls present extensive radiant heat absorbing surface permitting high firing rates with increased boiler capacity; furnace temperatures are decreased and furnace life prolonged. The cooler furnace reduces maintenance problems and increases efficiency.

● **Maximum "power for production" is today's goal of the boiler house operator. Increased steam demands cannot be met by new boiler units because of material shortages. Steam capacities can be increased, however, more efficient steam generation obtained, and critical materials conserved by the addition of waterwalls, superheaters and economizers to existing boilers.**

WHEELER

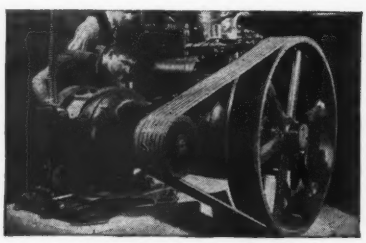
Good Team
Great Team

ALLIS-CHALMERS MOTORS AND TE

☛ **Using high-speed motors with Allis-Chalmers Texrope Drives and single-speed motors with Allis-Chalmers Vari-Pitch Sheaves and Speed Changers has always been good practise.** ***In time of war it's a vital practise!***

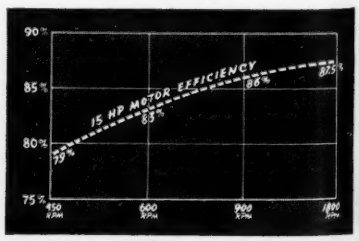
☛ **Such combinations give sharply higher efficiencies—at lower cost in man-hours, money and materials!**

☛ **Allis-Chalmers, only builder of *both* motors and V-belt drives, offers invaluable know-how in teaming them up.**



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY — WE PLAN FOR PEACE

ALLIS-C

in Peace . . .
in Wartime!

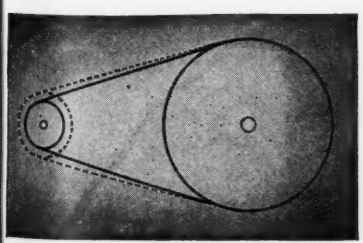
TEXROPE DRIVES

IT'S TIME to take a *fresh* look at motor buying! See below how much you can save with high- and single-speed motors made flexible by Texrope Drives.

Allis-Chalmers, builder of Lo-Maintenance Motors, originated the multiple V-belt drive and Vari-Pitch Sheaves . . . is the only manufacturer building *both* motors and V-belt drives. You benefit when you ask for — and get — the *right* combination of Lo-Maintenance Motor and Texrope Drive!

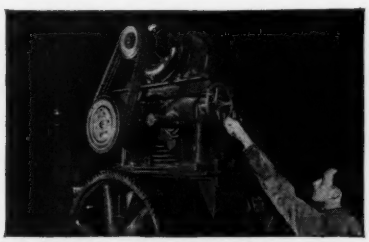
Call on your nearby Allis-Chalmers district office for facts, figures and advice — or write direct to ALLIS-CHALMERS MFG. Co., Milwaukee 1, Wis.

A 1627



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.

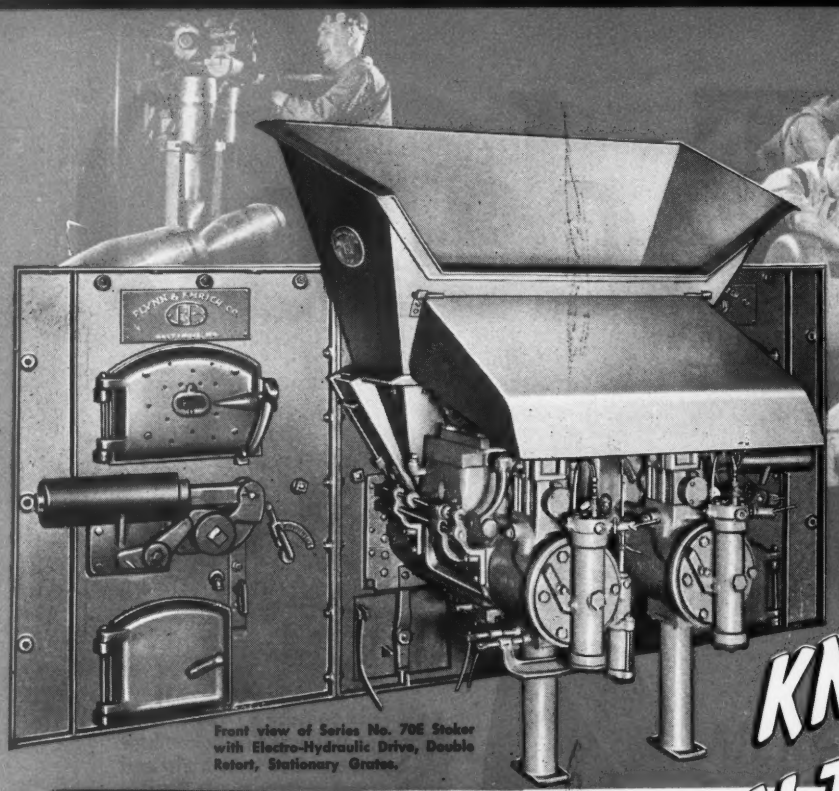
5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

ALLIS-CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES



Front view of Series No. 70E Stoker with Electro-Hydraulic Drive, Double Retort, Stationary Grates.

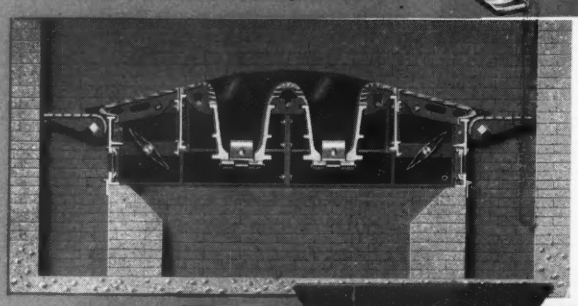
Horsepower has given America its superiority in Firepower. The flood of war goods streaming from war plants—large and small—is a tribute to those engineers who recognized that a dependable source of power was the answer to the battle of production for war—a foundation for sound post-war planning and a basic necessity for success in the coming competitive, peace-time markets.

KNEE-DEEP IN THE FIGHT

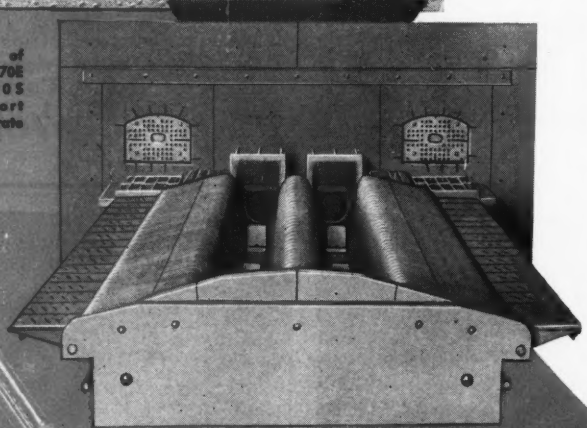
...BECAUSE THEY'RE DEPENDABLE

In hundreds upon hundreds of boiler rooms you will find "F&E" Underfeed Stokers on the job producing the Horsepower necessary to build engines and planes, tanks and guns, equipment and supplies for Victory. Day in and day out, they are proving their claim of Dependability.

The complete range of "F&E" Underfeed Stokers shown (1000 H.P. down to 24 H.P.) will satisfy the requirements of practically every boiler room. If you plan to convert to coal, if your boiler supplies heat or power, if your present production demands above-the-ordinary performance and if you are "post-war planning" then you will want to know just what an "F&E" Underfeed Stoker will do for you.



Cross section of the Series No. 70E and No. 70S Double Retort Stationary Grate Stoker.

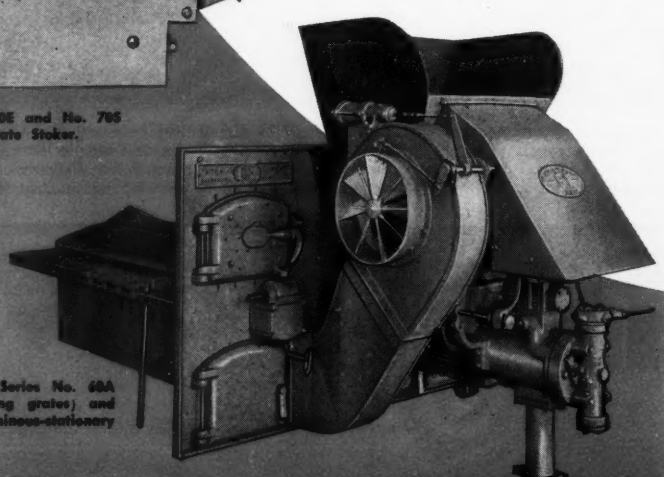


Rear view of Series No. 70E and No. 70S Double Retort Stationary Grate Stoker.

★

These illustrations show the rugged construction and the operating principles that characterize "F&E" Underfeed Stokers.

★



Front view of Series No. 60A (Anthracite-moving grates) and No. 60B (Bituminous-stationary grates) stoker.

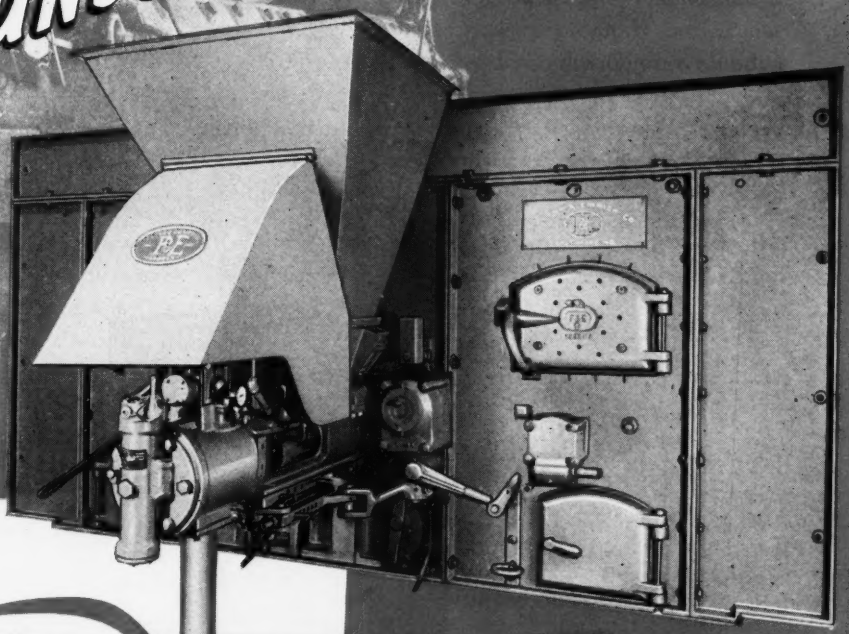
THE FLYNN & EMRICH CO.

Established 1842

BALTIMORE-2 • MARYLAND

REPRESENTATIVES IN PRINCIPAL CITIES

F&E UNDERFEED STOKERS



Front view of Series No. 70E Stoker with Electro-Hydraulic Drive, Single Retort, Moving Grates.

A COMBINATION OF FEATURES OFFERED ONLY BY "F&E"

1—Electro-Hydraulic Drive*

2—"F&E" Patented Interval Timer Governor

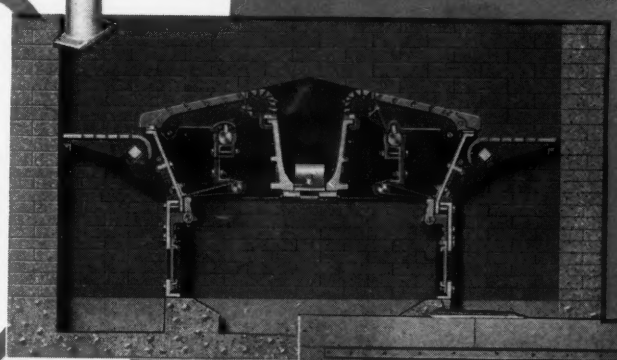
3—Fuel Bed Regulator

4—Sliding Bottom Retort

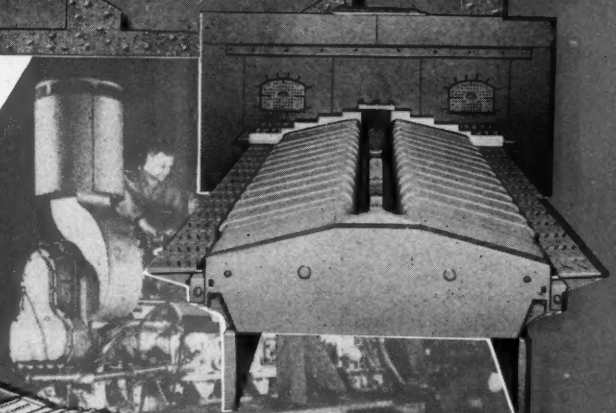
5—High Efficiency Tuyeres

6—Removable Ram Case Liner

**Steam Drive Available*



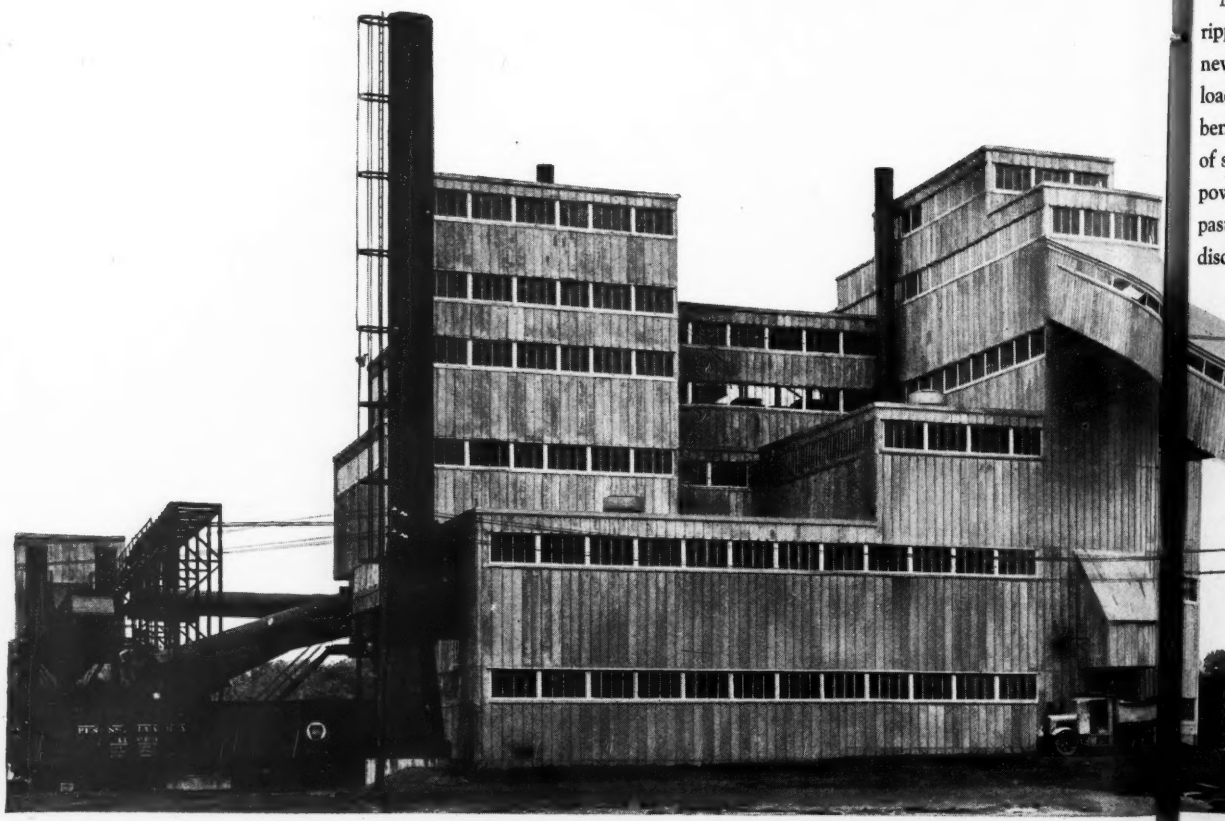
Cross section of the Series No. 70E and No. 70S, Single Retort, Moving Grate Stoker.



Rear view of Series No. 70E and No. 70S, Single Retort, Moving Grate Stoker.

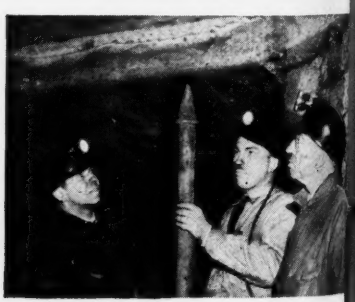
Front view of Series No. 48A (Anthracite-moving grates) and No. 48B (Bituminous-stationary grates) stoker.

They darned a rip a quarter of a mile long to keep coal moving to war industries



1 Here is the slope belt that carries coal from underground operations to the top of the coal preparation plant. The belt is 4 ft. wide and 1450 ft. long... more than a quarter of a mile. The entire coal output of the mine is carried on this extra strong belt.

2 The accident occurred just behind this dust screen. The firmly wedged, sharpened jack pipe acted as a perfect cutting tool... aided by the 250-h.p. drive of the belt motor. No belt is made strong enough to withstand such punishment.



3 This is the spear-shaped head of the 8-foot, hea steel jack pipe that fell into the rotary coal dum and pierced the belt and the steel decking flange became wedged so firmly that the j pipe had to be cut free with acetylene torch

4 Th thi ... tril em

UNITED STATES R

This million dollar coal preparation plant is one of the units that is enabling the coal mining industry to increase its output approximately ten per cent this year. Here, coal is washed, graded and prepared for shipment.

It's a tremendous plant . . . but its uninterrupted operation depends on the smooth functioning of the conveyor belt that carries coal from far below the surface of the earth to the top of the plant itself where grading and cleaning processes start.

Not long ago an unusual accident occurred which ripped more than 1400 feet of this extra strong belt. A newly sharpened steel jack pipe hurtled down with a load of coal. It pierced the belt and the steel decking beneath it . . . became firmly wedged between this sheet of steel and the coal-crushing rolls. But the 250-horsepower belt-drive motor droned on . . . drove the belt past this perfect cutting tool. When the damage was discovered and the belt stopped . . . plant operations came to a standstill. Shipments of fuel, vital to America's war industries and railroads, were halted.

Immediately the plant superintendent telephoned United States Rubber Company. *Would the plant have to shut down until a new belt was built, shipped and installed? Or . . . could it be repaired?* They said it could . . . made suggestions which were promptly carried out . . . 4600 rip plates required to do the job were rounded up by the local distributor of industrial supplies. The United States Rubber Company representative went to the plant . . . stayed on the job continuously until it was completed.

Twenty-five and one-half working hours later the plant was in full swing again. Coal flowed steadily from the mine. The quarter-mile rip had been darned . . . valuable rubber and equipment conserved . . . invaluable time gained.

Listen to the Philharmonic Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E. W. T. Carl Van Doren and a guest star present an interlude of historical significance.

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IN CANADA: DOMINION RUBBER CO., LTD.

4 The belt was repaired by bolting rip plates of thin steel through it. More than 4600 were used . . . approximately a ton of steel. The local distributor furnished the first supply; and arranged emergency shipments from factory stock.

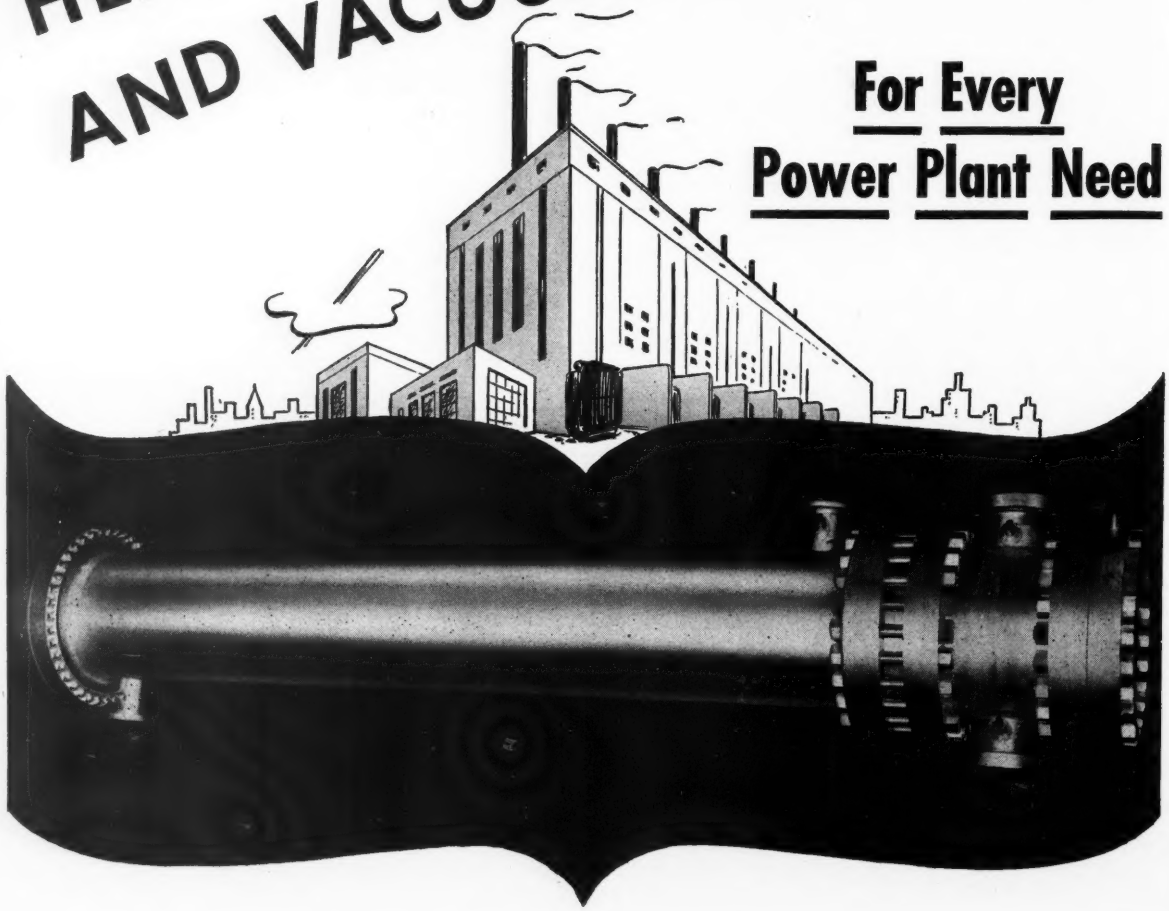
5 After the belt was repaired, it looked like this. The long rip has been darned successfully. The picture was taken after a test run of the belt had been completed satisfactorily and operations were ready to go into full swing again.

6 The plant is now working at top speed. Valuable time was saved . . . and very valuable rubber and equipment conserved. United States Rubber Company representatives and engineers are always on call . . . ready to step into the breach.

S RUBBER COMPANY

HEAT INTERCHANGE AND VACUUM EQUIPMENT

For Every Power Plant Need



As a major producer of heat interchange equipment, Lummus designs and builds a complete line of

★ Surface Condensers
★ Steam Jet Air Pumps
★ Bleeder Heaters
★ Boiler Blowdown Heat Exchangers
★ Evaporators
★ Fuel Oil Heaters
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The services of Lummus engineering personnel are available to public utilities and industrial power plants for the study of specific problems and the design of heat exchange and vacuum equipment to meet individual conditions.

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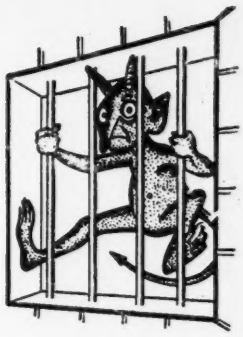
LUMMUS

Putting the acid-forming hydrocarbon in its place



(or how to avoid turbine oil acidity)

Hydrogen and carbon atoms in petroleum are united in more combinations than you can shake a stick at. Although most of these unions are contented, some are not. They're unstable. They crave oxygen. When they get it, they change from benevolent Dr. Jekylls to murderous Mr. Hydes. Then look out for your turbine! Look for deposits, sludge, acidity, poor demulsibility, etc. Some of these oxidized hydrocarbons tend to form asphaltenes, others to form acids. Particularly devilish are the kind that become acidic. These cause or contribute to about every kind of turbine oil trouble there is. They gripe oil men because they can't all be removed by any refining process yet discovered. Some of them remain in the oil, in spite of all that science has been able to do. Here is where Nonpareil Turbine Oil affords a great and unique advantage. It contains a patented inhibitor. Because of this inhibitor, all acid-forming hydrocarbons are locked up and rendered incapable of doing harm. As a result, we are able to give a written guarantee that Nonpareil's acidity (as expressed by neutralization number) will never exceed 0.15. In service, it is more likely to be around 0.05, as hundreds of turbines have proved after 5 to 16 years of operation. How we eliminate trouble from both asphaltenes and acids will be told next month. Meanwhile, if you want further information, send for a Standard Lubrication Engineer.

Write or phone the nearest Standard Oil Company (Indiana) office, or 910 South Michigan Avenue, Chicago, Illinois. In Nebraska, Standard Oil Company of Nebraska, at Omaha.

NONPAREIL TURBINE OIL

Oil Is Ammunition . . . Use It Wisely

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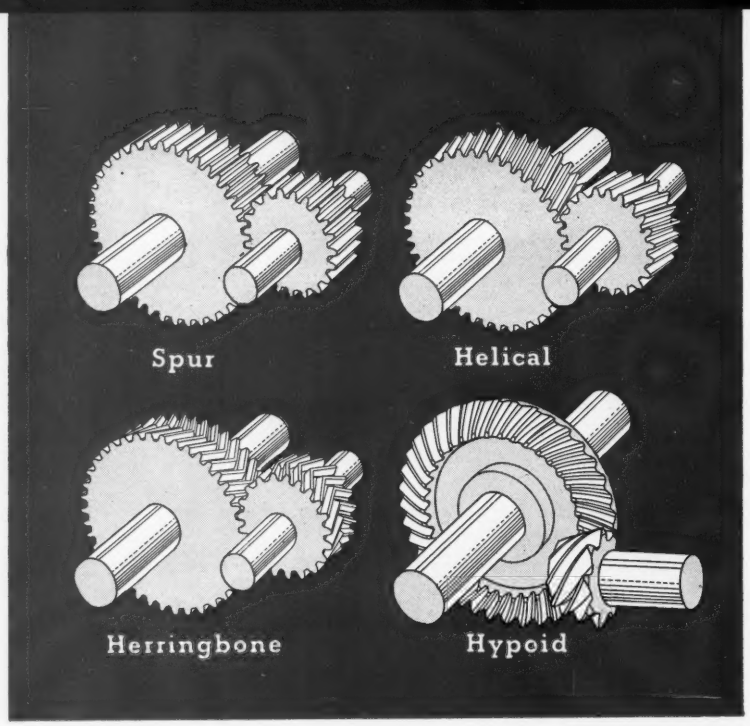


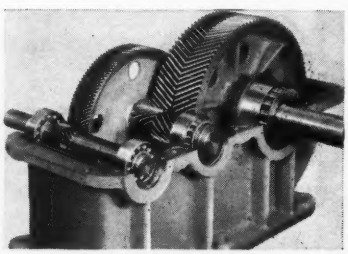
Help for hard-pressed teeth

• FOR HIGH external temperatures combined with heavy tooth loads, high load peaks or shocks, and also for exposed locations with extreme variation of external temperature, a leading gear manufacturer specifies the use of extreme pressure lubricants. This recommendation is in line with much of our experience.

These lubricants provide a load-carrying capacity many times that of straight mineral oils. They prevent scoring and galling of teeth when pressures are too great for protection by ordinary oil film. In the top flight of this type of product are Stanogear Leaded Lubricants. These lubricants have an endurance far beyond that of the usual E. P. lubricant, and therefore require changing much less frequently. Here are typical examples of the results they give:

Stanogear more than match for trouble-maker. Excessive wear and scuffing were troubling a midwest battery plant using a set of large, broad herringbone gears to drive a zinc rolling mill. Pressures were high, there was considerable shock load, gears ran very hot.

A number of makes of lubricants were tried without correcting the trouble. Then a Standard Lubrication Engineer was called in. He recommended Stanogear Leaded Lubricant No. 6X because it lubricates the teeth in spite of high pressures and results in lower gear temperatures. Also, it is highly stable and does not form the excessive deposits sometimes associated with the use of such products.



Herringbone speed reducer. This type of unit may be subjected to high external temperatures, combined with high peak or shock loads. Prevention of excessive wear may require use of high quality extreme pressure lubricants, such as Stanogear Leaded Lubricants.

To make doubly sure, the Engineer recommended spray application at the point of contact, resulting in further temperature reduction. These recommendations were adopted over a year ago, and the manufacturer has enjoyed trouble-free operation ever since.

Again Stanogear to the rescue. Here's another case of trouble going out when Stanogear Leaded Lubricant came in: A central west metal working plant was having excessive wear on a three-speed transmission driving a cut-off saw, and involving a chain of gears in an enclosed case. The oil level at the lower end of the case was only about three inches deep and there was a vertical lift of approximately 16 inches to the top gear. Several gear replacements had been required during an eight-months' period, using a conventional S.A.E. No. 90 automotive gear lubricant.

When a Standard Lubrication Engineer was called in, he recommended Stanogear Leaded Lubricant No. 3X. Its excellent load-carrying characteristic provided positive lubrication, with the result that there has been no evidence of excessive wear in about 18 months.

How to get help quickly. If you are having any trouble with power transmission equipment, let a Standard Engineer help you keep it doing its full wartime job. He has a complete line of lubricants which meet the many and varied requirements of this type of service. He also has had experience with ironing out difficulties with the same kind of equipment you use in your plant. For the Engineer nearest you, phone or write the nearest Standard Oil (Indiana) office, or 910 South Michigan Avenue, Chicago, Illinois. In Nebraska, address any Standard Oil Company of Nebraska office.

Oil is ammunition . . . Use it wisely

STANOGEAR
LEADED LUBRICANTS

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

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Warships or merchantmen — their arteries are pipe.

We make anything in tubular or plate steel fabrication: Fabricated Piping — for steam, water, air, oil, gas, chemicals • Random mill or cut lengths, bent, coiled, welded, flanged, threaded • Valves, Pipe Fittings.

Send us your inquiries.

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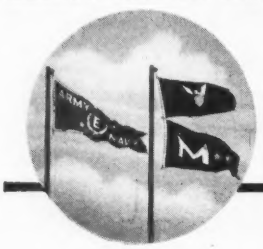
For these B&W BOILERS

At the ripe age of 40, five of these central-station B&W boilers of 1902 were recently drafted for work in a Southern war plant, thereby saving critical materials that would have been required in the construction of new boilers for this service.

A lot of steam flowed from their charcoal-iron, hammer-welded tubes since they were first placed on the line, yet, when they were given a careful "physical" this year by the inspectors, they were pronounced hale and hearty, ready for induction into war service.

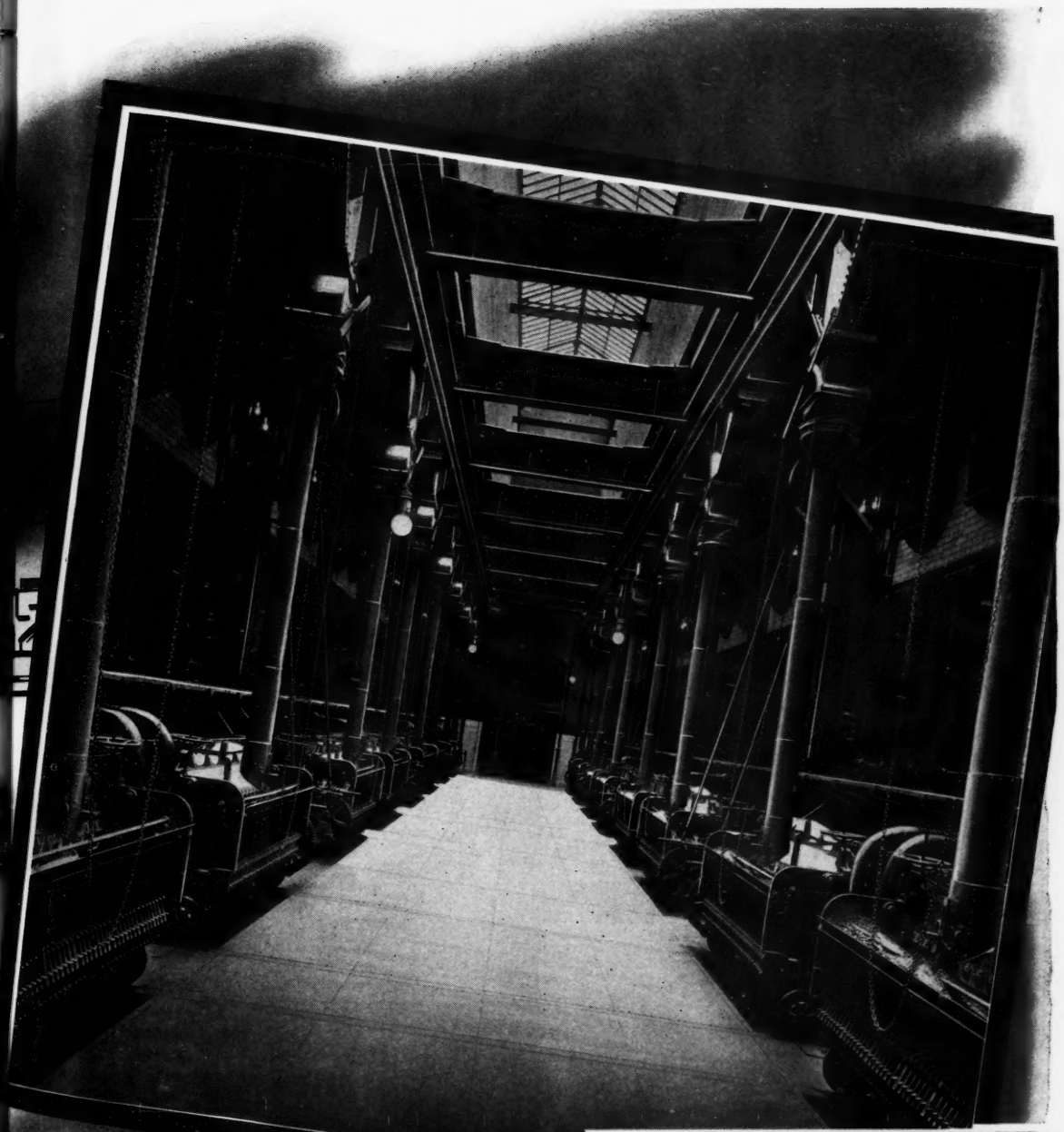
This fact testifies not only to the soundness of their design, but to the excellence of the materials and workmanship that entered into their construction 'way back in 1902—always a matter of pride with the manufacturers of B&W boilers. It also testifies that the boilers must have received excellent care from their operators.

And these are only five of many B&W boilers, that, after long and useful lives in other fields, are being drafted for reinstallation in war industries, where, incidentally, they will continue to receive the benefits of B&W engineering and service.



The Army-Navy "E" with two stars and Maritime Commission Award flags are floated proudly at the Barberton Works.

"VICTORY is a job for steam ...and steam is a job for B&W."



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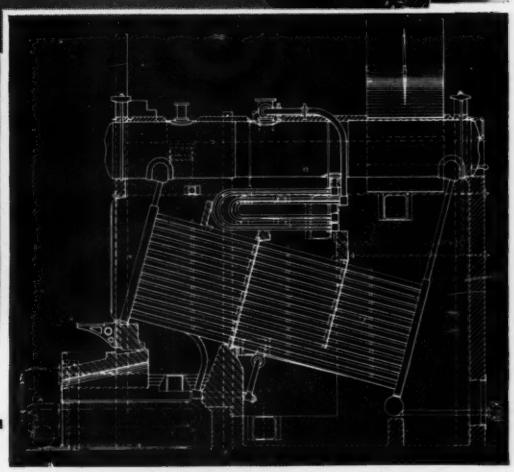
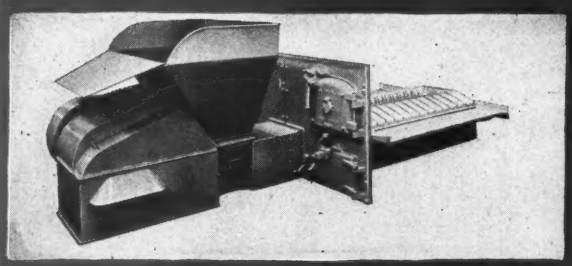
BABCOCK, WILCOX & COMPANY, 1867
THE BABCOCK & WILCOX COMPANY, 1881

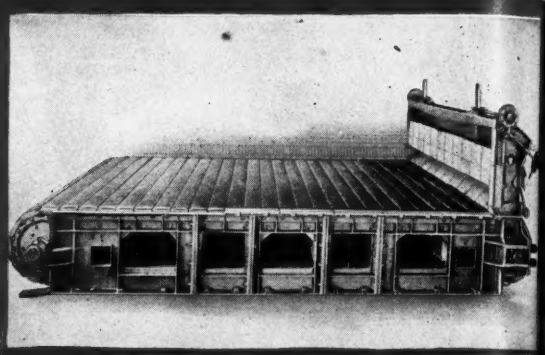


G-252T

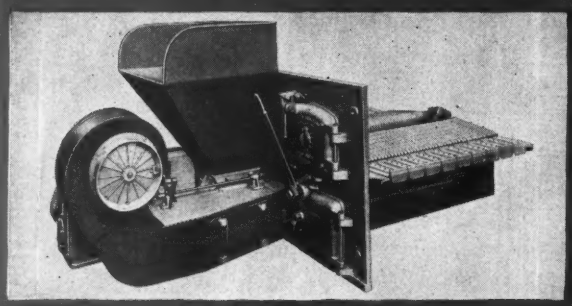
200,000,000 GALLONS



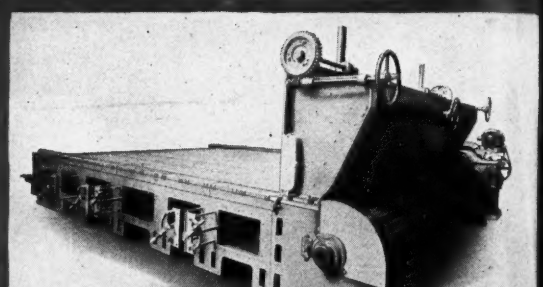
C-E SKELLY STOKER



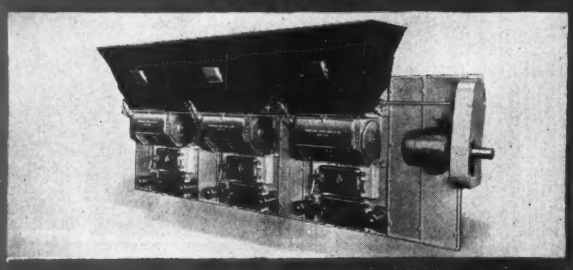
C-E TRAVELING GRATE STOKER



C-E LOW RAM STOKER

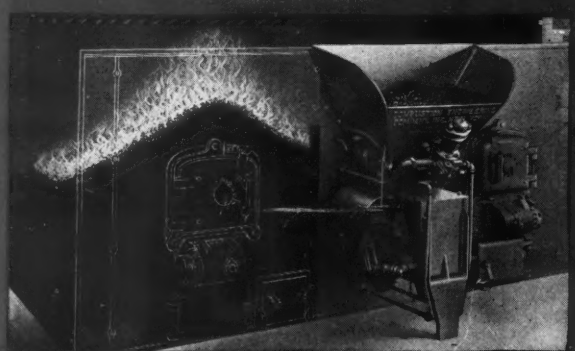


C-E CHAIN GRATE STOKER



C-E SPREADER STOKER

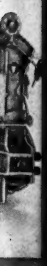
C-E MULTIPLE RETORT STOKER



C-E TYPE E STOKER

S OF FUEL OIL A YEAR!

saved by C-E Conversions



As of July 1st, C-E orders for conversion installations represented an aggregate annual saving of well over 200,000,000 gallons of oil. And this figure is based on conservative assumptions as to rates of operation and hours in service.

What this means in the conservation of today's most vital natural resource may be judged from the fact that the transportation of this quantity of oil would require about 20,000 tank cars, or, to put it another way, it represents the saving that would be achieved by converting some 135,000 average homes from oil to coal firing.

All Types of Fuel Burning Equipment

Although the big majority of these C-E conversion installations consist of single-retort underfeed stokers, such as the Skelly, Type E and Low Ram, they include all the other types of C-E Stokers illustrated on the opposite page, as well as C-E Pulverized Coal Systems.

This fact is emphasized because it reveals one of the chief advantages of calling on C-E to help you with your conversion problems. Like the hundreds of plants which have already taken this step, you will be sure of getting the best type of fuel burning equipment for your particular conditions. Why? Because C-E has the most extensive line of fuel burning equipment offered by any manufacturer and correspondingly broad experience . . . experience based on the equipping of over 5,000,000 boiler horsepower with stokers of all types.

A Point to Remember

And, if you are going to convert, here's an important point to remember. Your coal burning installation can be a source of substantial saving to you not only for the duration but for many years thereafter. So don't regard it as a temporary expedient but rather as a long-term investment that will yield you returns in direct proportion to the quality of the equipment you buy and its suitability for *your* plant.

It may still be possible to complete your conversion before cold weather if you act now. Write, phone or wire C-E today. Your inquiry will be referred to the district office nearest you for immediate attention.

A 745

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Canadian Associates

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C-E

Installation of Super Refractory Brick in Various Types of Boiler Furnaces

The drawings and explanation below are based upon recent installations of Crystolon (Silicon Carbide) brick in boiler furnaces. Results have been completely satisfactory when the directions given here were followed.

Crystolon brick are proving satisfactory for today's war-time need of uninterrupted peak operation. Produced at high temperatures these brick are particularly resistant to extreme heat. Their hardness makes them resistant to the abrasive action of ash and the motion of the fire bed.

The surfaces of Crystolon brick are sufficiently dense to prevent molten ash from taking hold by penetration and this same density enables them to resist the erosive action of slag.

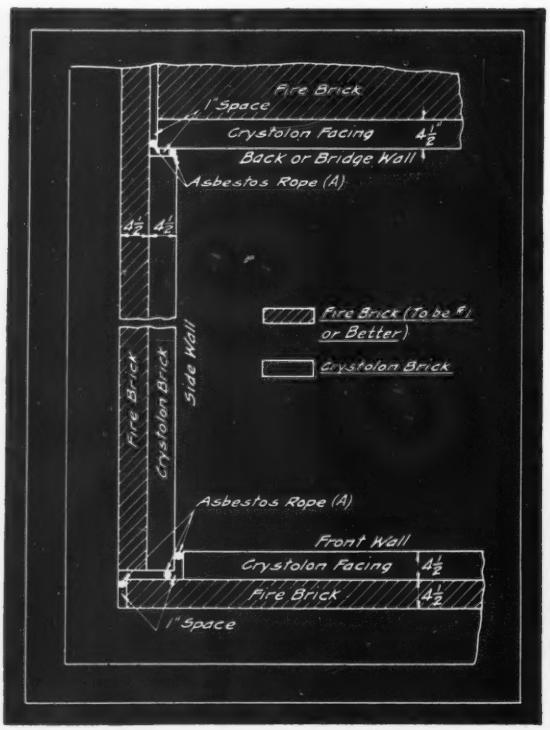

FIG. 1 *Typical Setting Showing Expansion Joints (A)*

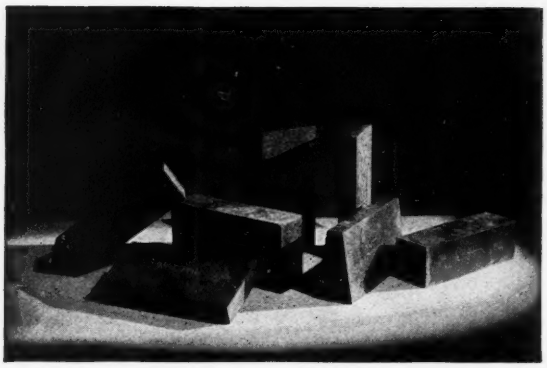

FIG. 2 *Crystolon Brick for Boiler Furnaces*

Other types of refractory brick often necessitate shutdowns or down-time to remove the clinker. While the clinker may sometimes adhere to Crystolon brick to a limited extent, these brick are sufficiently rugged to withstand the rather rough barring action that is commonly used to knock off the clinker.

Super refractory brick although costlier than ordinary fire brick actually give more economical service through reduced maintenance time and longer life.

It is advisable to use the same construction in the bridge wall as is shown (Fig. 1) for the side wall when Crystolon brick are used.

In cases where it may not be convenient to put in expansion joints as shown (see A, Fig. 1), expan-

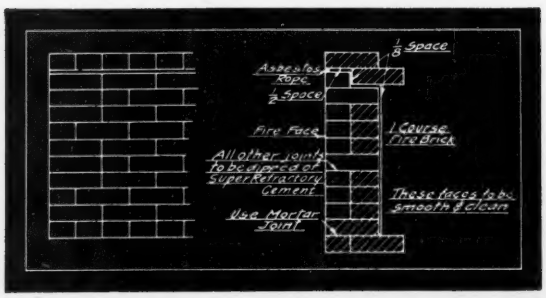
⅛ Space
Asbestos Rope
½ Space
Fire Face
1 Course Fire Brick
All other joints to be ⅛ space of Super Refractory Cement
These faces to be smooth & clean
Use Mortar Joint

FIG. 3 *Construction Using from 9 Courses up to 4' of Crystolon Brick*

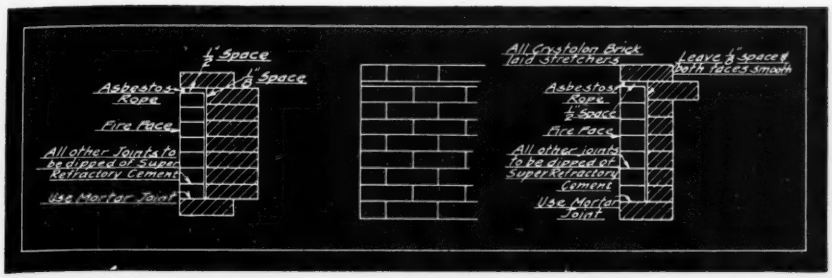
½" Space
¼" Space
Asbestos Rope
Fire Face
All other Joints to be dipped of Super Refractory Cement
Use Mortar Joint
All Crystolon Brick laid Stretchers
Leave ¼" space & both faces smooth
Asbestos Rope
½" Space
Fire Face
All other joints to be dipped of Super Refractory Cement
Use Mortar Joint

FIG. 4 *New Construction (left) and Repairing Old Construction (right) Where 7 Courses or Less Are Used*

sion can be taken care of by leaving $\frac{1}{16}$" to $\frac{1}{8}$" open joint between each brick in the stretcher courses or every second brick in a header course. In any case, expansion allowances must be made. A good rule to use is approximately $\frac{1}{8}$" expansion to 15" of Crystolon brick in the wall.

For best results, not less than five courses of Crystolon brick should be used in any boiler furnace except in cases where exceptionally thin fire beds are carried and peculiar conditions of operation might justify the use of fewer courses.

In general, five to nine courses are used depending on the type of stoker, size of furnace, thickness of fuel bed carried and rating at which boiler is to be operated. If too few courses are used, there is danger of a slag curtain building down from the fire brick above and interfering with the efficiency of the Crystolon brick.

Always use a super refractory cement* for laying up the Crystolon brick. A dipped joint is best in laying Crystolon brick, unless otherwise specified. The brick should be hammered down tightly to make as nearly a face-to-face joint as possible. *Do not use ordinary fire clay or fire brick cements nor any of the groups known as air-setting or air-hardening cements in contact with the Crystolon brick.*

*Send for Norton Refractory catalogs: Cement No. 863-Crystolon Brick No. 862.

In the center retort, side-dump type of stoker the Crystolon brick should be started 3" below the nose of the dump plate.

In the multiple retort type of underfeed stoker the Crystolon brick should start at the grate line and follow the slope of the stoker, using a few more courses of Crystolon brick in the side wall toward the rear of the stoker. It is well to use standard jamb or bull nose and arch brick to build around the rear inspection door.

In the chain grate type of stoker the Crystolon brick should be laid directly on the side wall bed plate or in any case should start slightly below the top of the chain grate. In the case of one type of Cox stoker now in use a special Crystolon brick is employed with a $\frac{1}{2}$" cut-out which fits directly over the side wall plate.

In hand-fired boiler furnaces it is common practice to start the Crystolon brick an inch or two above the top of the grate.

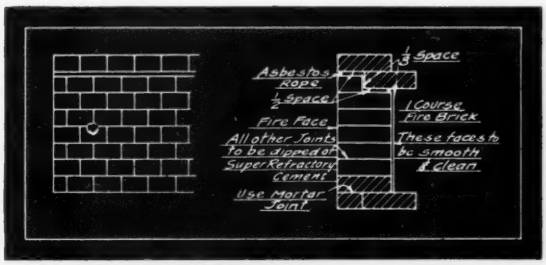
½" Space
Asbestos Rope
½" Space
Fire Face
All other Joints to be dipped of Super Refractory Cement
Use Mortar Joint
1 Course Fire Brick
These faces to be smooth & clean

FIG. 5 *Construction Using 9" Crystolon Wall All Headers up to 4' in Height*

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FOR DRUMHEADS . . . SKINS

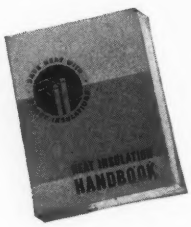
...and for INSULATION *85% Magnesia*

Ever since the primitive drums of the African jungles first beat out their signal messages, a stretched skin has invariably been the basic sounding medium. Time has proved this to be the *one* material for the purpose.

* * *

And in the field of pipe and boiler insulations, there is *one* material which, for more than half a century, has also proved that it can "take a beating"—85% MAGNESIA. Countless service records in practically every branch of industry bear indisputable testimony to 85% Magnesia's efficiency, long life and economy.

Industrial insulating materials cost but a small fraction of the money they save. Make sure of the permanence of your insulation investment by continuing to specify Ehret's 85% Magnesia.



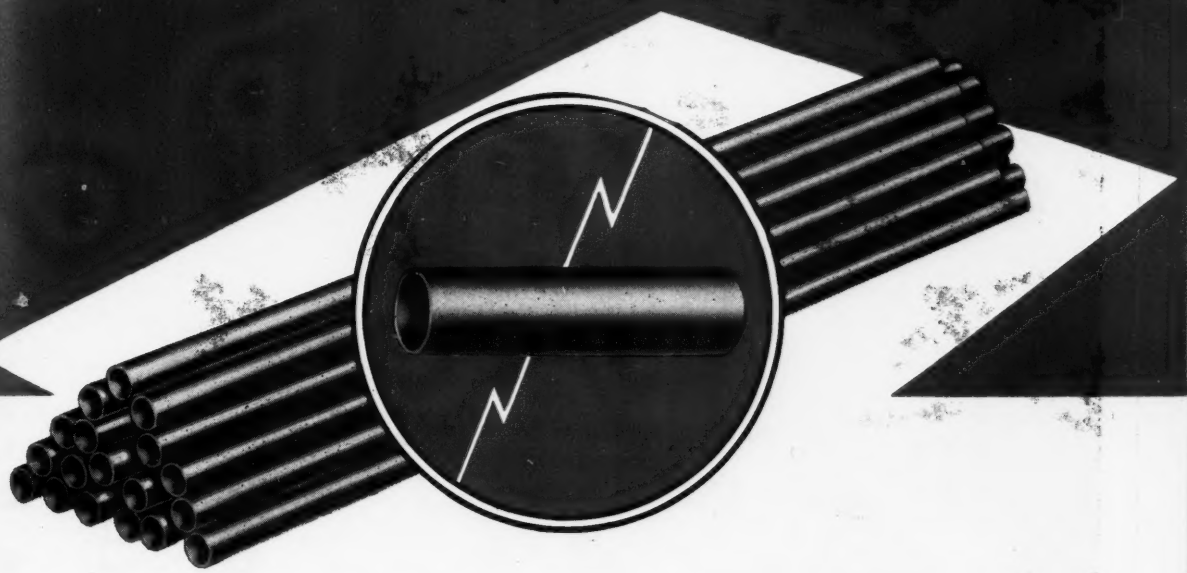
EHRET'S 85% MAGNESIA and many other Ehret heat insulating materials are fully treated, both as to selection and application, in the 176-page Heat Insulation Handbook. It will be furnished, without obligation, to those interested in getting the most from their thermal insulations. Write today for your copy.

EHRET MAGNESIA *Ehret* **MANUFACTURING CO.**
VALLEY FORGE, PENNA.

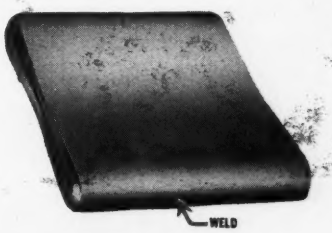
...THERE IS AN *EHRET* DISTRIBUTOR OR CONTRACTOR IN EVERY INDUSTRIAL AREA

UNIFORMITY FOR SAFETY...

...with Talon's Electric Welded Steel Tubing



CONTROLLED uniformity of Talon's Electric Welded Steel Tubing begins with the desired chemical and physical specifications of the hot-rolled strip from which it is formed. It assures safety, ease of fabrication, great strength, and low cost. Close gauge tolerances guarantee uniform wall thickness, concentricity, and unvarying light weight. No surface defects are hidden. Both the inside and outside surfaces undergo constant inspection from production of the strip, through the cold-forming operation on the tube mill, to final inspection. Every foot is hydrostatically tested to withstand tremendous pressure. Size is held consistently on long runs of a given diameter by micro-gauge adjustment of the forming rolls. Talon's Electric Welded Steel Tubing is now made in most sizes from ¾" to 4" O. D.—up to 60 feet in length. These and other sizes will be available for your peacetime production at low cost.

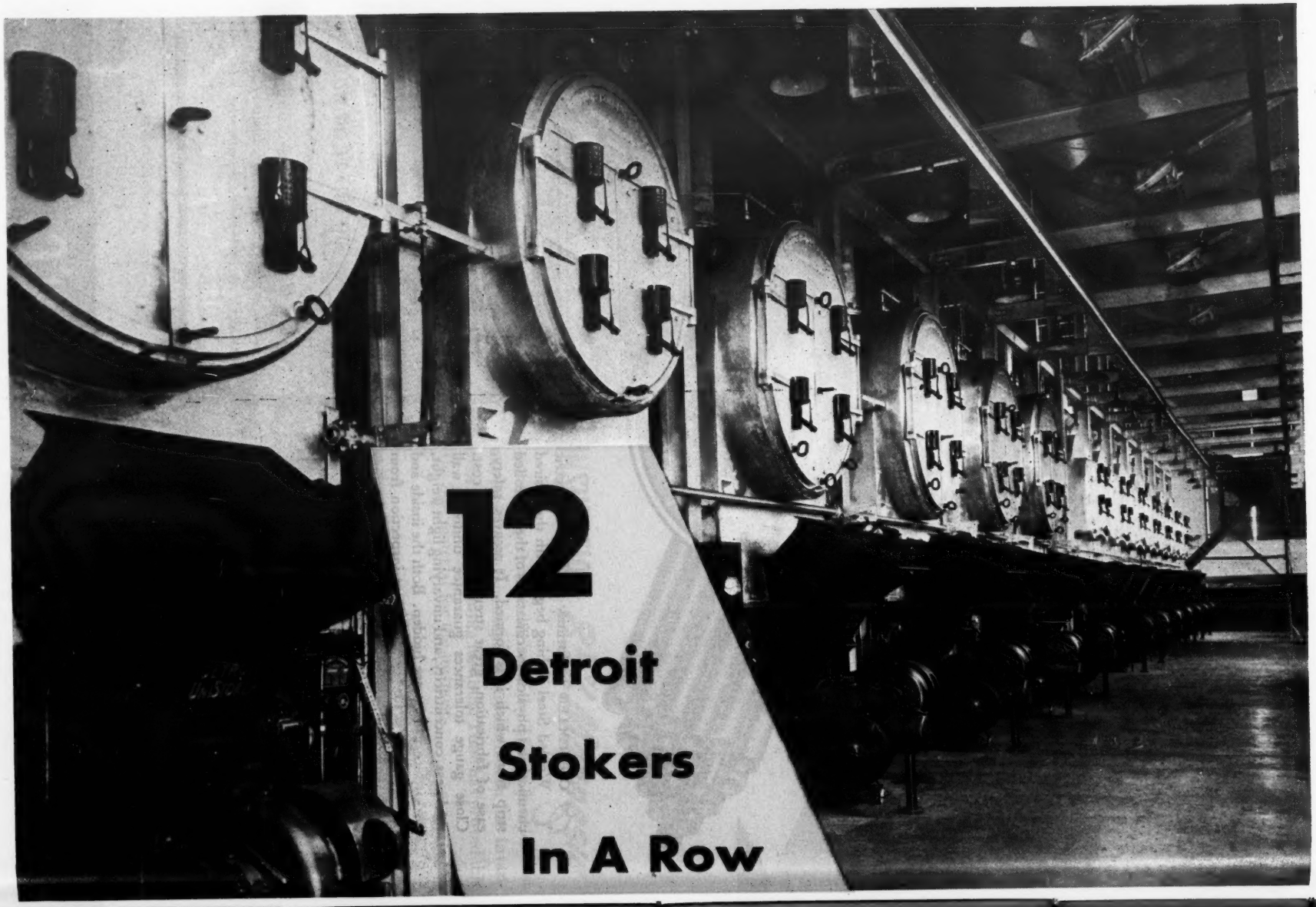


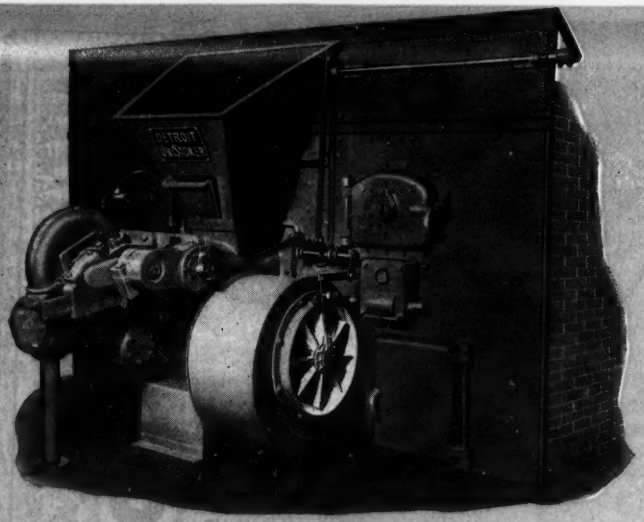
TESTING THE STRENGTH OF THE WELD

Flattening test—with maximum bending at the weld. Talon's Electric Welded Steel Tubing exceeds the permissible limits of all standard tests for physical properties.

TALON . . INC.

STEEL TUBE DIVISION OIL CITY, PENNA.


12
Detroit
Stokers
In A Row

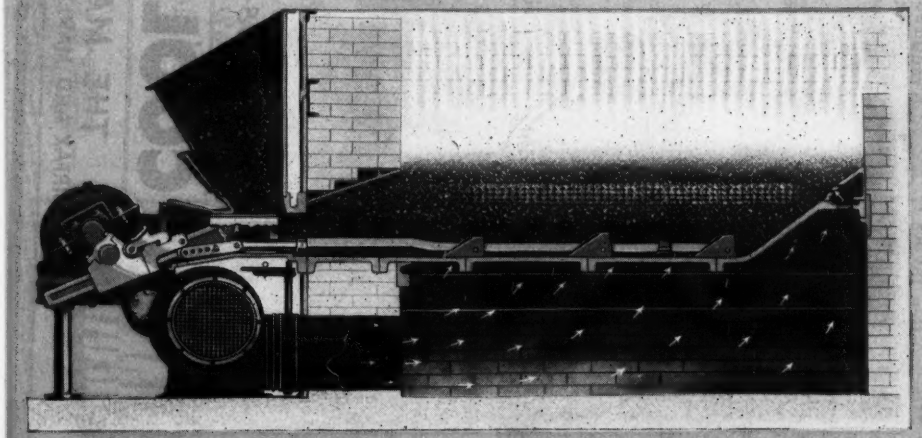


Detroit UniStoker is of a compact design, motor or steam turbine driven, automatically controlled.

Serving A Large Defense Plant

Extreme flexibility and stability of Detroit UniStokers provided the exact characteristics needed in this Large Defense Plant.

Five contracts for 12 Stokers with 250 horsepower boilers. Each UniStoker has an Adjustable Coal Feed that provides accurate regulation of fuel feed and air supply for all capacities.



Detroit UniStoker has large capacity. Adjustable Feed Insures proper distribution, regardless of the load.

WRITE FOR BULLETIN 624

DETROIT STOKER COMPANY

Fifth Floor, General Motors Building, Detroit, Michigan

Works at Monroe, Mich. • District Offices in Principal Cities

Built in Canada at London, Ontario

A LESSON IN WATER COOLING

LESSON 2 OF A SERIES

COOLING TOWER FANS

Practically all cooling tower fans today are of the propeller type, due to this type's simple construction, low cost and ability to handle large volumes of air at relatively low pressures with good efficiency.

Cooling tower fans are mounted in two ways, known as "forced draft" and "induced draft." Following the development of proper methods and reliable equipment to drive the induced draft fan wheel, this type has been used on the majority of mechanical draft towers since it draws air through the decks and falling water at more uniform velocity and with less turbulence or friction loss than the forced draft fan. Being located at top of tower and in a horizontal plane, the induced draft fan provides these additional advantages: (1) less noise, (2) fan wheels of greater diameter can be used, (3) smaller tower area and foundation, (4) winter icing troubles avoided, (5) improved appearance, (6) used air expelled at high velocity from top of tower does not tend to "recirculate." Modern practice favors fans of larger diameters than formerly, so that fewer are required for a given service. The result is less first cost, less wiring and starting equipment, less maintenance and some power saving.

It is good practice to equip fans with two-speed motors. At half speed less than 20% of the total power is used while air volume through the tower is fully 50% or more. Also the two-speed motor provides flexibility in balancing power consumption with load and cold water requirements, facilitates winter operation, and reduces wear and resulting maintenance.

Adjustable pitch fan blades, now widely used, are not an operating feature once the tower is in service but are a means whereby the manufacturer can compensate for variances in altitude, speed and static pressure, thus obtaining desired cfm. at the prescribed brake horsepower.

Good cooling tower fan design embodies such additional features as eased inlet, extended discharge ring, minimum obstruction in inlet or outlet, and motor located outside the air stream.

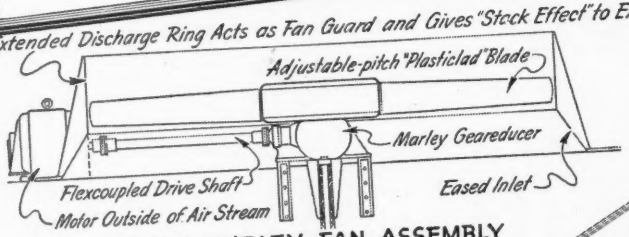
FAN LAWS

For a given fan size, air flow system and air density:

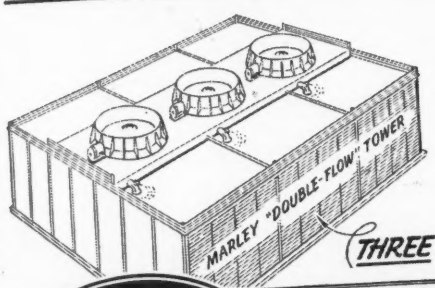
1. **Air capacity varies directly as the fan speed.**
2. **Pressure (static, velocity and total) varies as the square of the speed.**
3. **Horsepower varies as the cube of the speed.**

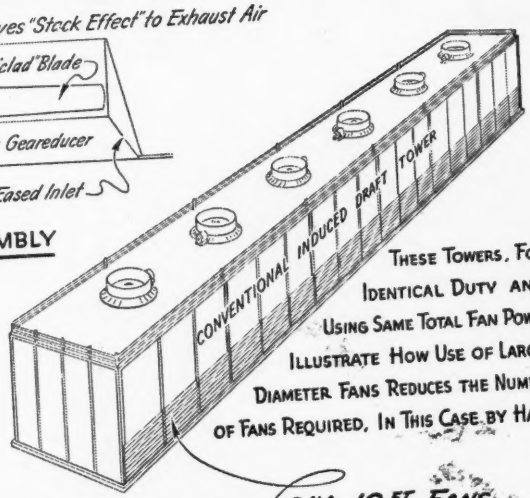
$$\text{Air Horsepower} = \frac{\text{CFM} \times \text{Total Pressure, Inches Water}}{6356}$$

$$\text{Input HP, Motor} = \frac{\text{Air Horsepower}}{\text{Fan. Eff.} \times \text{Drive Eff.} \times \text{Motor Eff.}}$$


Extended Discharge Ring Acts as Fan Guard and Gives "Stack Effect" to Exhaust Air
Adjustable-pitch "Plasticlad" Blade
Marley Geareducer
Flexcoupled Drive Shaft
Motor Outside of Air Stream
Eased Inlet

CROSS SECTION MARLEY FAN ASSEMBLY





THESE TOWERS, FOR IDENTICAL DUTY AND USING SAME TOTAL FAN POWER ILLUSTRATE HOW USE OF LARGE-DIAMETER FANS REDUCES THE NUMBER OF FANS REQUIRED, IN THIS CASE BY HALF

THREE 18 FT. FANS INSTEAD OF SIX 12 FT. FANS

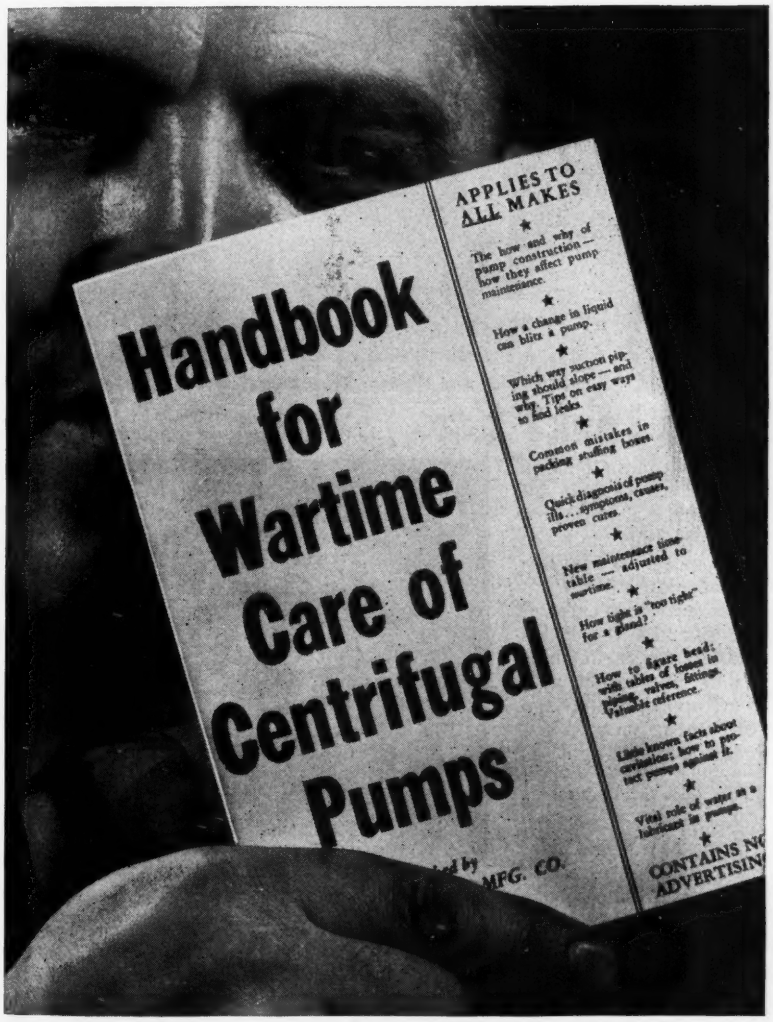
MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC.

FAIRFAX AND MARLEY ROADS — KANSAS CITY, KANSAS

3-43-A

"It's Tops on Pumps!"


Handbook for Wartime Care of Centrifugal Pumps
APPLIES TO ALL MAKES
★
The how and why of pump construction — how they affect pump maintenance.
★
How a change in liquid can blitz a pump.
★
Which way suction piping should slope — and why. Tips on easy ways to find leaks.
★
Common mistakes in packing stuffing boxes.
★
Quick diagnosis of pump ills . . . symptoms, causes, proven cures.
★
New maintenance time-table — adjusted to wartime.
★
How tight is "too tight" for a gland?
★
How to figure head; with tables of losses in piping, valves, fittings. Valuable reference.
★
Little known facts about cavitation; how to protect pumps against it.
★
Vital role of water as a lubricant in pumps.
★
CONTAINS NO ADVERTISING

When you do need new pumps—take a good look at the extra efficiency, ruggedness and long life built into Allis-Chalmers centrifugal pumps . . . the famous "Electrifugal" — and all types for every purpose. Meanwhile, let "Handbook for Wartime Care of Centrifugal Pumps" help you make present pumps *last*! →

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WE WORK FOR VICTORY — WE PLAN FOR PEACE

YOUR TECHNICAL LIBRARY ISN'T COMPLETE UNTIL IT HAS A COPY OF ALLIS-CHALMERS' GREAT NEW PUMP MAINTENANCE GUIDE. IT'S FREE —SEND TODAY!

MOST BOOKS on pump care published before the war are *seriously out of date* today! Why? Pumps that used to work 1800 hours a year now work as many as *8700* hours! For *timely* aid get "Handbook for Wartime Care of Centrifugal Pumps!"

A pump is built, step by step, on paper. Tips and tables show how to diagnose, how to remedy trouble — apply to all makes of pumps. *It's Free*! Tear out and mail order form below today!

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Milwaukee, Wisconsin

Gentlemen:

Yes, I would like to receive *free of charge* a copy of your "Handbook for Wartime Care of Centrifugal Pumps".

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(Title)

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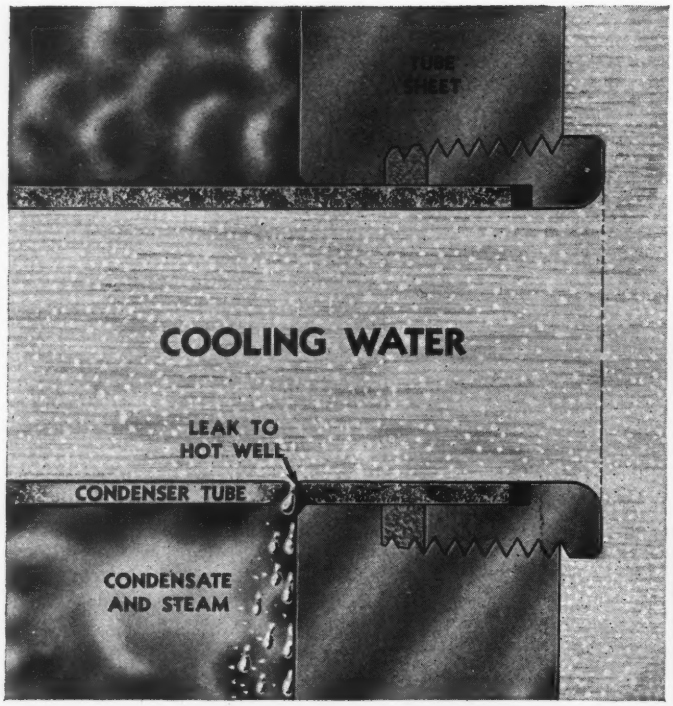


ARMY NAVY
depends on me!
A Slogan For All Americans

Want to IMMOBILIZE this Leak?

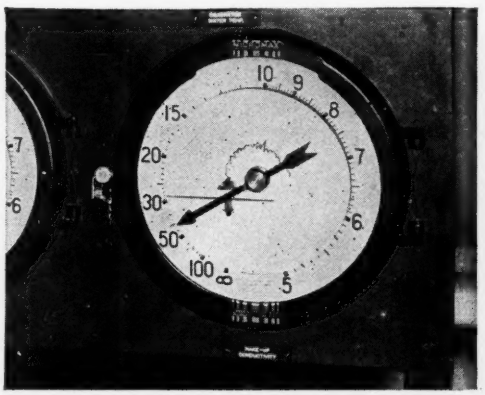
To keep contaminated condensate from sneaking into a boiler's tubes and sabotaging its steam production, we can supply an instrument which will warn of the potential damage at its source until the maintenance crew closes the leak and thus ends the contamination. The method employed is to measure, continuously, the electrolytic conductivity of the condensate.

In the power industry's steam stations, conductivity is checked at each surface condenser, and after the pump, and at the drains of the stage heaters, by a multiple-point Micromax Strip-Chart Recorder. This instrument records the points, in rotation, at a rate of about a minute per point, on a chart approximately ten inches wide; the record may be in one color or in as many as six. The Micromax sounds an alarm or operates a signal light, as you prefer.

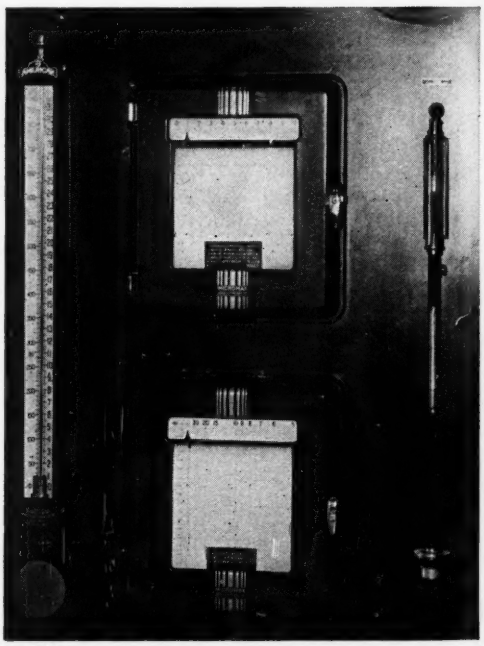
In many industrial power plants, where the condensate comes principally from the heaters for digesters, evaporators, cookers, etc., the preferred Micromax Recorder is apt to be a single-point instrument, normally connected to the main condensate return. When a leak shows, a dump valve opens to run the condensate to waste, while an operator switches the Recorder's connections, by hand, to the various lines which feed the header, until he has run down the leaking unit. The Recorder used may be either a Strip-Chart or a Round-Chart; the latter gives a narrower record but its indicating scale is readable from almost as far as it can be seen.

Both Micromax Recorders are highly dependable, perfected machines, with long histories of satisfactory service in this application. They are described in Catalog N-95-163, sent on request; but if you have a war-job in which conductivity measurement could help, outline it to us, and we will promptly send more specific recommendations.

TYPICAL INSTALLATIONS



Typical Micromax Round-Chart Conductivity Recorder guarding the condensate return of a pulp mill. Calibration is in thousands of ohms.



Typical Micromax Strip-Chart Conductivity Recorder, on a central station's turbine board. It shows conductivity at hot well, or conductivity of condensed evaporator vapor, as manually selected. The upper instrument is a Micromax Temperature Recorder for steam, water and air temperatures; each is in a separate color.

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-95-163(4)

The First Line of Defense

No matter how badly the steel mills need scrap, a turbine or boiler will aid the war effort more by staying on the job than by going on the scrap pile.

Inactive equipment . . . equipment nearing condemnation . . . often can be made to serve you for many more months and years when protected — the quick, easy, low-cost way — with APEXIOR. And new equipment can be preserved at peak condition by this essential maintenance and operating material.

The Paint Takes the Wear

Hundreds of industrial power plants, utilities, railroads and marine operators have been using APEXIOR to lengthen the life of boiler or turbine metal. Applied with a hand brush or power-coater, APEXIOR seals up the pores and joints and provides a long-lasting, corrosion-resistant, scale-resistant covering for the metal. The APEXIOR takes the wear, not the metal — and one application lasts 2 to 3 years or more. It is easily renewed.

Painting boiler metal with APEXIOR is recommended by boiler insurance companies. And many manufacturers of turbines coat shafts, rotor bodies, and frequently interiors of casings with APEXIOR before shipping to customers.

APEXIOR is the safe, sure answer to lack of new equipment — the solution to your problem of getting more out of your present equipment. APEXIORIZE — you'll save valuable metal — and in the case of boilers, you'll lengthen periods between cleaning and make cleaning easier (with a wire brush).

Users like these have applied APEXIOR for years. It will help YOU get more service from irreplaceable equipment.

U. S. Army
U. S. Navy
U. S. Maritime Commission
U. S. Coast Guard
U. S. Bureau of Yards & Docks
U. S. Marine Corps
Cunard White Star, Ltd.
New York Central Railroad
Chicago & Northwestern Railroad
Georgia Power Co.
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●

Ease of Applying APEXIOR Explained — Cleaning Simplified

Write, today, for Bulletin 1290 (Industrial) or 1305 (Marine) telling how to get peak production with peak protection.

APEXIOR

A Peacetime Plus ★ ★ ★ A Wartime Must

RECOMMENDED BY ALL U. S. AND CANADIAN BOILER INSURANCE COMPANIES

The **DAMPNEY COMPANY**
of America
protective coatings for
STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

THE DAMPNEY COMPANY OF AMERICA
Hyde Park, Mass.

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Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.

Minutes lost are dollars lost

ON THE GREAT LAKES

That's why they're so discriminative about boiler water conditioning for steamships

ON these big "self-unloaders" that ply the Great Lakes, boilers must be kept going every minute the steamship is in service. As a result, every shut-down for boiler cleaning can be put down as cash loss, and you can be sure the owners of these ships are plenty choosy about boiler water conditioning. An example is the S. S. George F. Rand, illustrated above. Her boilers get no shore leave whatever. They not only generate steam for propulsion; they also generate steam to operate the unloading machinery when she is in port. Her owners, Boland & Cornelius, say that any shut-down would cost them more than a dollar a minute.

Incidentally, Boland & Cornelius are the largest owners and operators of self-unloaders in the world. In view of this, we believe you will agree that the selection of Elgin Boiler Water Conditioning for the Boland & Cornelius fleet is highly significant.

As a matter of fact, a larger majority of Great Lakes steamships have come to the Elgin organization for the solution to their water conditioning problems, and we know of no higher tribute to the ability of our organization to lick water conditioning problems in the most direct, most economical, most dependable way.

Many of these steamships use Elgin individually prescribed water treatments with the Elgin Deconcentrator for removing sludge and suspended matter from the boiler water. Perhaps your problem will respond to this highly successful method, but whatever your problem it will pay you to put it in the experienced hands of the Elgin engineering staff.

ELGIN SOFTENER CORP., 136 N. Grove Ave., Elgin, Illinois

The Elgin Line Is All-Inclusive

- ★ BOILER WATER TREATING AND PURIFYING SYSTEMS
- ★ FEEDWATER TREATMENT
- ★ DECONCENTRATORS
- ★ HEAT EXCHANGERS
- ★ WATER SOFTENERS
- ★ FILTERS AND PURIFIERS
- ★ OIL REMOVAL FILTERS
- ★ IRON REMOVAL EQUIPMENT
- ★ AERATORS
- ★ WATER TREATING CHEMICALS
- ★ CHEMICAL FEEDERS
- ★ SCALE AND CORROSION INHIBITORS
- ★ SAMPLE COOLERS
- ★ WATER TESTING EQUIPMENT
- ★ ZEOLITES

Elgin individually prescribed water treating chemicals available for any need. Prompt shipments.

Elgin Zeolites for increasing capacity of zeolite softeners shipped immediately from stock.

Descriptive bulletins, engineering data and layouts on request. Write today.

ELGIN WATER CONDITIONING FOR EVERY NEED

Safer Boiler Operation
Easier Maintenance with

SPECIFY!

ERNST FITTINGS

Fig. 4
Standard Type—Offset Adjustable Inclined Gage Fittings

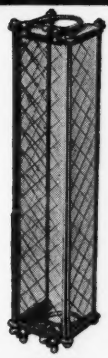


Fig. 9
Wire Glass "Better-C" Guards, All Sizes

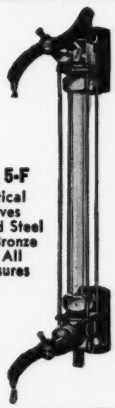


Fig. 5-F
Vertical Valves Forged Steel and Bronze for All Pressures

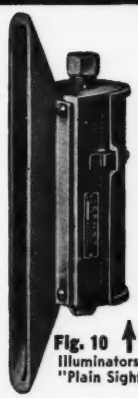


Fig. 10
Illuminators—"Plain Sight"

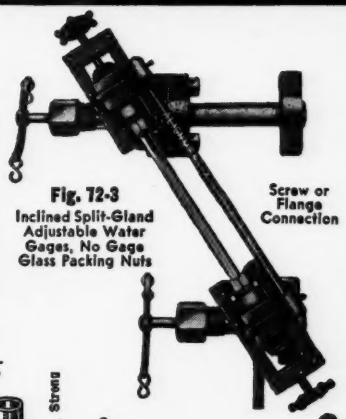


Fig. 72-3
Inclined Split-Gland Adjustable Water Gages, No Gage Glass Packing Nuts

Screw or Flange Connection

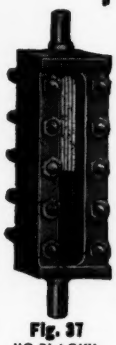


Fig. 37
"C-BLACK" Prismatic Flat Glass Inserts

Fig. 46
"C-Clear Thru" Flat Glass Inserts

Fig. 18 Fig. 18
FLAT GLASSES

GAGE GLASS GASKETS

Standard Pattern Gaskets
High Pressure
Non-hardening and Non-softening SERIES 750
Fig. 22
Send for Gasket Tag showing sizes
GASKETS THAT WILL FIT EXACTLY
Lip-mold Pattern
Expansion Type Gasket
Fig. 21

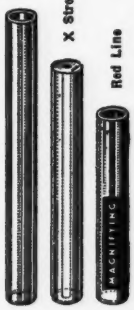


Fig. 12 Fig. 23 Fig. 14

LEAKLESS COCKS

Fig. 13
Bronze or Forged Steel
For All Pressures

Fig. L-150
Steam Metal Bronze Gage for pressures up to 150 pounds

Fig. 16

SIGHT GLASSES for all types OIL CUPS and LUBRICATORS

Fig. 17

SIGHT FLOW INDICATORS for insertion into Pipe lines —All Sizes—

NAVY GAGE

Fig. N-10

Fig. 15

For Pressures Up to 250 lb. — This Ernst DCP (Double Chain Pull) Try Cock insures a tight shut off. Order in sets of 3 to complete one water column.

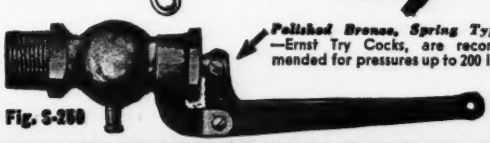
Fig. 8
All Iron Gages for Refining and Chemical Industries

We also manufacture..

SAFETY ALARM WATER COLUMNS
FOR ALL TYPES OF BOILERS COMPLETE WITH TRIM

DELIVERIES FROM STOCK
ORDER BY FIG. NUMBERS

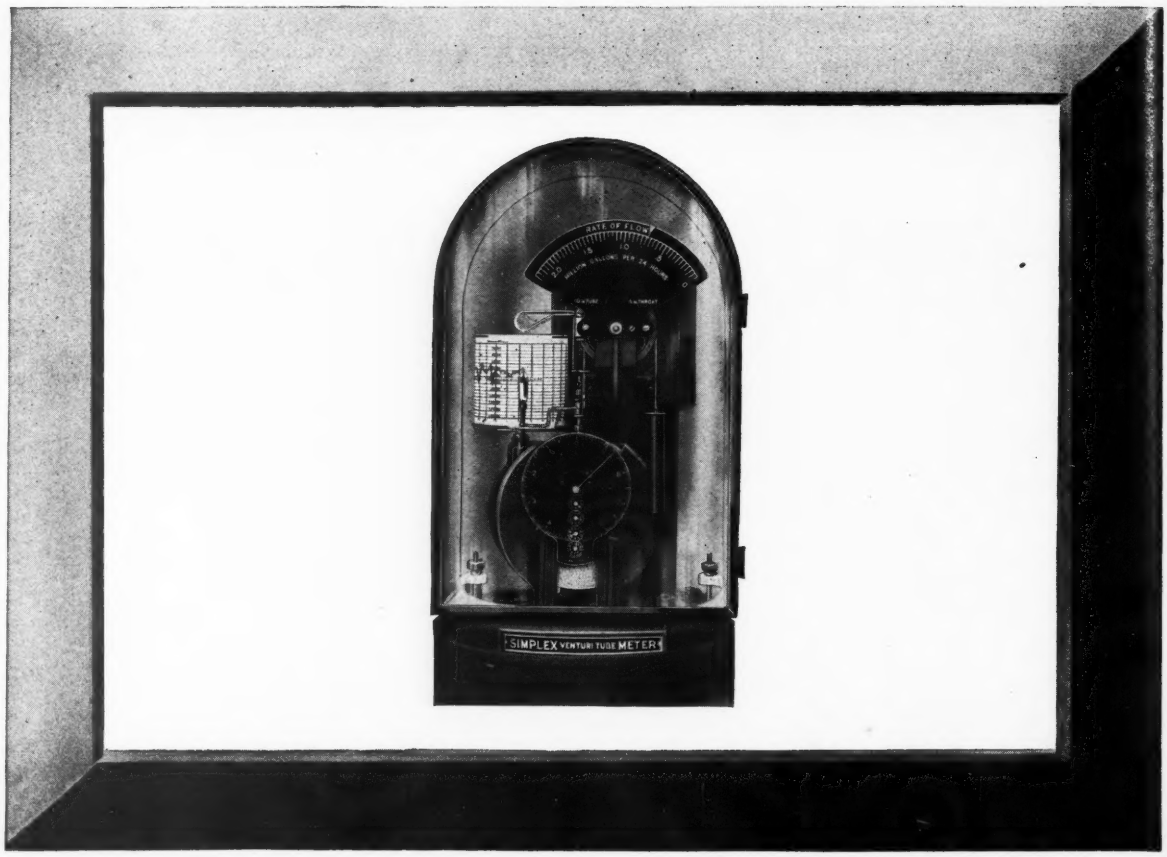
SEND FOR COMPLETE CATALOG and State Your Requirements



Polished Bronze, Spring Type —Ernst Try Cocks, are recommended for pressures up to 200 lb.

Fig. S-250

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J. *Manufacturing For More Than 35 Years* Phone: Livingston 6-0276



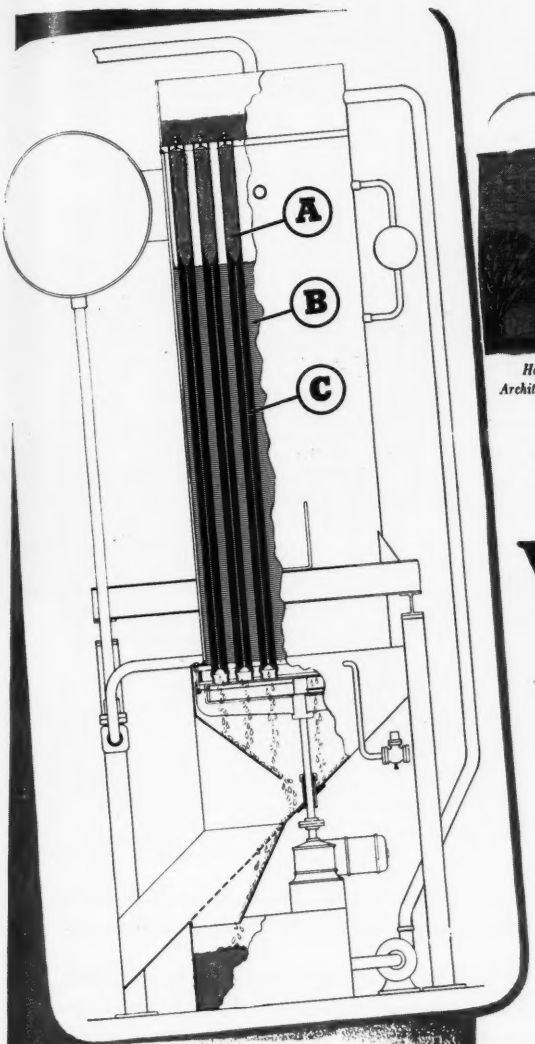
Portrait of "A MIND AT EASE"

Simplex Type "MO" flow meters have established a reputation for long, dependable service that is taken for granted by thousands of operating men in power plants all over the country.

We receive many comments from new as well as old users telling us of the steady, behind-the-scenes job being done by this "master meter to check all other meters." The "MO" gives unequalled range of flow measurement; extreme sensitivity to the smallest measurable changes in differential head; and an over-all measuring efficiency which takes many a burden from the shoulders of already overworked operating staffs.

The Simplex "MO" meter indicates, records, and totalizes fluid flows with year-round, trouble-free accuracy. We will gladly send you complete information on the "MO" meter. . . . Simply address

SIMPLEX VALVE & METER COMPANY
6783 UPLAND STREET, PHILADELPHIA, PENNA.



THE FREEZING CYCLE

A-Water circulating through tubes of freezer.
B-Refrigerant surrounds tubes and causes water to freeze to inner wall of tubes.
C-Ice cylinders forming in tubes.

Five ton unit discharging "crushed" tube-ice.

Holabird & Root
Architects and Engineers

The WASHINGTON STATLER
introduces

Vogt TUBE ICE
TO THE TRAVELING PUBLIC

Score another FIRST for Statler . . . with Tube-Ice!

Statler was first to provide guests with a morning newspaper, to have running ice water and a radio in every room, and a dietician in its hotels. Now, it introduces a new kind of ice at the nation's most modern hostelry . . . a clear, hard ice of can-ice quality and appearance . . . Tube-Ice.

Here two Automatic Tube-Ice Machines, one of five tons "cylinder" ice capacity and the other of six and one-half tons "crushed" ice capacity each twenty-four hours provide sized ice for a great variety of refrigerating purposes. Chief of these is the preservation of freshness and flavor in foods and for beverage cooling. The machines use Freon as a refrigerant and operate on 15 lbs. suction pressure.

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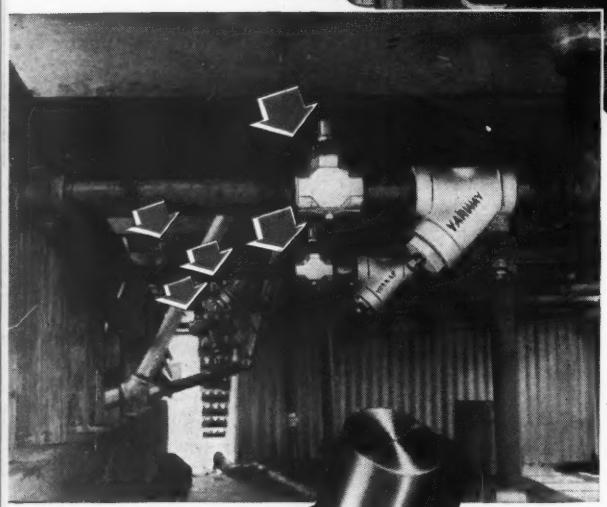

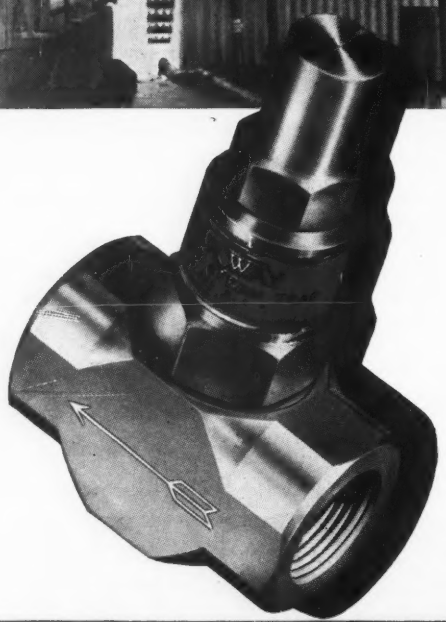

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YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Fuels Supply and Demand

By A. C. FIELDNER

THE POST-WAR UNITED STATES eventually may be forced to rely on domestic coal and oil shale deposits as additional sources of liquid fuel. During the war, coal has taken over much of the burden formerly carried by petroleum. Because of the heavy consumption of petroleum products many of the industrial conversions from fuel oil to coal may remain after the war.

Expected higher prices for fuel oil will tend to discourage new installations using this fuel. The greatest concern for the future supply of oil is the continuing decline during the past four years in the discovery of new fields. This calls for a marked increase in exploration to keep current withdrawals from reaching the point where total recovery is diminished.

To aid in forestalling such a possibility, Petroleum Administrator for War Harold L. Ickes has suggested the drilling of 4500 "wildcat" wells during 1943, compared with 3045 wells drilled in 1942.

If this enlarged exploration program is unsuccessful in restoring our former rate of finding new reserves of oil, the present trend of substituting coal for the industrial and domestic use of fuel oil may continue, and ultimately supplementary supplies of liquid fuel from oil shale, coal, and vegetable products may be required. It is too early to make any definite predictions in this respect, but it is not too soon to give thoughtful consideration to this problem.

In 1942, William P. Cole, Jr., former chairman of the Petroleum Subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives stated that "with our present transportation and present rate of discovery, showing any regard for conservation, we will be short of oil within two years."

It is evident that the post-war trend probably will be in the direction of greater conservation of our national petroleum resources and in their more effective utilization. War-time progress in the production of high-octane aviation gasoline may lead to its use in improved types of combustion engines designed to obtain more mileage per gallon.

If prices of motor fuel rise because of decreasing supplies, more attention may be given to secondary recovery from depleted fields and to the application of more expensive refining processes, such as pressure-hydrogenation of low-grade crudes. It is probable, also, that the Fischer-Tropsch process will be applied to the conversion of natural gas to gasoline. Large reserves of natural gas are available for such conversion in parts of the United States remote from our present centers of population and industrial activity.

If these and other technical developments, together with the conceivable importation of oil from foreign sources, fail to meet the demand, prices may advance to the point where the production of liquid fuel from oil shale, coal, lignite, and renewable vegetable sources will be economically feasible.

Most of the nation's bituminous coals and lignite can be liquefied by the Bergius pressure-hydrogenation process and all ranks and grades of coal can be converted to liquid fuel by way of water gas.

Both processes (Bergius and Fischer-Tropsch) are in commercial use in Germany. There, more than half of the supply of gasoline is thought to be made from bituminous and brown coal. Costs by these methods are estimated to be three to four times that of producing gasoline from petroleum in the United States.

The Committee on Petroleum Reserves of the American Petroleum Institute estimated the proved petroleum reserve to be 21.2 billion barrels on January 1, 1942, and 20.7 billion barrels on January 1, 1943. Reserves during the last five years have been kept up by extensions and revisions of estimates of reserves in old fields rather than the discovery of new fields. Regardless of whether we are on the threshold of a permanent decline of petroleum production or whether new discoveries will postpone this period for several decades, it is evident that our reserves of gas and petroleum are small compared to reserves of coal.

Deposits of oil shale, largely in the Rocky Mountain states, are estimated to contain a potential supply of 92 billion barrels of crude oil — sufficient to maintain the 1941 annual rate of oil production for 65 years.

The ultimate reserves of natural gas cannot be established, but the estimated proved reserve as of January 1, 1942, was 85 trillion cu ft.

At the 1941 rate of 2.77 trillion cu ft of production per year, this amount would last 30 yr. Here, also, new sources may be discovered and the life of the fields, no doubt, will be extended greatly as growing social control will prohibit waste and low-grade use of this ideal fuel.

The original reserves of coal and lignite were estimated to have been 3.2 trillion tons, and not more than two per cent of the original supply of bituminous coal and about 30 per cent of the anthracite have been exhausted.

At the 1941 rate of energy consumption, assuming that coal will carry the load if and when oil, gas, and oil shale are exhausted, and allowing 30 per cent for mining losses, coal would last 1500 to 2000 yr. However, there certainly will be an increase in energy demand; an increase at the rate of increase prevailing during the 1920's would cut the period to some 500 yr, and shortage of supply would be felt in the Appalachian field in a hundred yr.

During 1943, various branches of the coal-mining industry are aiming for an all-time high of 665 million tons of coal, of which 600 million tons will be bituminous and lignite.

To accomplish this record production in the face of growing war-time handicaps of lack of transportation, manpower, and new equipment is a problem that calls for the best efforts of the mining and transportation industries.

Dr. A. C. Fieldner is chief of the Fuels and Explosives Service, U. S. Bureau of Mines. His intimate knowledge of the country's fuel problems has been gained from much personal research and work in all phases of the field. He was graduated from Ohio State University in Chemical Engineering in 1906. After serving as an industrial fuel engineer for Denver Gas & Electric Light Co. and as chemist for American Zinc & Chemical Co., he joined the U. S. Geological Survey where he did research in fuels and their utilization. In 1907, when the Bureau of Mines took over this work, Dr. Fieldner was put in charge of the fuels and gas chemical laboratories. He became a major in the Chemical Warfare Service in 1917 in charge of the Gas Mask Research Division, was made superintendent of the Pittsburgh Experiment Station of the Bureau of Mines in 1921 and chief chemist in 1925. In 1927 he was made chief of the experiment stations and in 1936 chief of the Technical Branch and chief engineer of the Coal Division. A degree of Doctor of Science was conferred on him by the University of Alabama in 1936. He is a member of the ASTM, AGA, ACS, AIM&ME and other technical bodies. The data presented here are from a recent address to the Western Society of Engineers, Chicago

HIGH SPEED HEATING

Electronic heating, that is, the application of high frequency waves and industrial heating processes, is doing many war jobs faster and with more precise localization of heat than ever before. The results obtained with this type of heating are quite amazing. It is possible, for example, to heat one end of a nail so fast that one end can be held between the fingers while the other end is heated to a red heat. The surface of a metal object can be heated to a red heat while the interior is still cold. ¶ New electronic heaters recently developed by the General Electric Co. make possible hardening, brazing, and soldering operations in seconds instead of minutes. These equipments are essentially power oscillators which convert 60-cycle power to high frequency power at approximately 500,000 cycles and the standard sizes have power outputs of 5 and 15 kw. ¶ The photographs above show a typical application of this method of heating, that of surface-hardening a small bushing. In the first picture at the top left, Anne Gallik of General Electric's industrial heating and welding division is about to insert the bushing into the inductor coil. She could put her finger into this coil and feel no heat but the steel bushing she holds can be heated red hot in a matter of seconds. In the next photo the bushing is inserted in the coil and Anne pushes a button which puts the heater to work. In $3\frac{1}{2}$ sec the surface of the bushing reaches a red glow temperature of 1550 F. As shown in the third photograph, a timer cuts off the current automatically and turns on a violent spray of water. This quenching fixes the hardness and the operation is complete.

WITH THE EDITORS

◆ **STEAM, HYDRO, DIESEL**—Sometimes in the development of industry, offshoots of the parent industry become so important that they cast a shadow over the industry's foundation. Is such a development taking place in the field of power generation by steam?

This question had its inception in a letter received recently from a young man seeking advice regarding the future of power generation. He has started on a career as a steam power engineer. Recently he has heard and read so much about Diesel and hydro power that he inquires "Would I be foolish to continue my study of steam engineering or should I turn to Diesel?"

That, of course, is a personal question, but back of his question is a thought which needs clarifying. To make the question of general interest we might reword it thusly: Has steam power generation actually reached the point where it is on the decline? We decidedly do not believe that it has. Hydraulic turbines, Diesel and gas engines have their places in the economic scheme of power generation where steam cannot compete, but steam is still the master power.

Power as a service to human activity is not merely a branch of any particular industry, it is an industry itself with many branches. It is as distinct an industry as the automotive, railroad, coal, aviation, food process or any one of many other divisions of human endeavor.

The production of power, that is the conversion of some form of energy into that form we call power, either mechanical or electrical, which is applicable for the performing of work, is in fact only a part or branch of the industry. Definitely in the field of power engineering, and so considered by factory and building managers, are such services as space and water heating with steam, the supplying of compressed air, pumping water for all purposes, the care and maintenance of electric lighting, refrigerating systems, air conditioning units. In fact, the power engineer is usually the individual in any establishment who is best informed on the details of all mechanical and electrical equipment using the services originating in the power house. In this service to industry, steam maintains mastery today.

In our choice of power generating units, consideration should be given not merely to immediate economy but how we can make best use of present sources of energy while developing replaceable sources for future generations. The U. S. Bureau of Mines has studied this problem thoroughly and states that at the current rate of consumption the coal reserves of the United States are ample for hundreds, if not thousands of years. The life of petroleum and natural gas resources now in sight is estimated at 15 and 30 years, respectively. By costly methods of converting coal to oil the supply of oil might last for centuries.

Water-power resources which depend chiefly upon the sun, topography and vegetation, may seem to be the most susceptible of measurement; nevertheless, volcanic action or the convulsions of nature can change the centers of water power production.

◆ **HYDRO POWER**—From the viewpoint of conservation of natural resources, the available water power sites should be developed as a source of power, even if somewhat contrary to economy of today. In the United States this has been done to the extent that about one-third of the power distributed by public utilities is generated in hydraulic plants. Industrial and other plants are so located that only a small part of the power used comes from hydraulic plants. Any heat such plants must supply comes either from steam boilers or electrical heaters frequently used for generating steam.

Through the history of power generation, hydraulic power was for a long period the only practical mechanical power available to industrial plants. Its use declined into second place when steam power was made available, and today it owes its relative economic position in the field to the fact that power transmission by electrical means has made it possible to use electricity in industrial centers far from its point of generation. Future development and expansion have natural and economic limitations plainly evident to engineers.

◆ **INTERNAL COMBUSTION ENGINES**—The employment of Diesel and gas engines must today be based strictly on their economy as power generators. Without question the conversion of the heat in the oil or gas used as fuel into mechanical power can be done far more efficiently in Diesels or gas engines than through the more indirect medium of steam. They have, however, the disadvantage that the fuel now used is irreplaceable in nature, diminishing in supply, and comparatively high in price.

Substitute fuels are not now commercially available but there is the possibility that a replaceable fuel such as alcohol may some day take the place of oil if it can be manufactured with sufficient economy.

Internal combustion units have been handicapped in their application by the fact that commercial means of recovering heat losses have lagged behind in their development. Diesel units as employed almost universally today are for power generation only. Only occasionally are installations made where the waste heat is recovered. The limited capacity of Diesel units as compared with steam turbines is another handicap which may in time be overcome by development of the gas turbine.

◆ **STEAM POWER**—Generation of power through the medium of steam under pressure is generations old and each generation has contributed ideas that have been worked out economically to improve efficiency and give greater service to industry. Fuels of every type are being used for steam generation. In many plants factory wastes supply the fuel necessary for steam generation. The process of developing more efficient fuel-burning and steam-raising equipment and methods is going on continuously, even with recorded steam generating efficiencies above the 90 per cent mark.

In industrial and institutional plants where steam is required in abundance, power is generated as a byproduct taking, in round numbers, only about 10 per cent of the heat value out of the steam, the remainder, except for losses, going to processes.

Turning to statistics, we find that the capacity of hydraulic turbines in manufacturing plants has remained almost constant at 1,750,000 hp since 1919; internal combustion engine capacity has increased about 500,000 or from 1,250,000 to 1,750,000 hp from 1919 to 1939, the last census figures available; while steam power generating units (engines and turbines) increased from 16,700,000 to 17,300,000 or 600,000 hp. Thus we see that the percentage gain is decidedly in favor of internal combustion engines, but the total capacity is little more than one tenth that of steam power capacity.

In the public utility field, Edison Electric Institute reports for 1942 show that power generated during that year by steam engines and turbines was 123,236 million kw hr; by hydro, 63,985.6 million kw hr; and by internal combustion engines, 1,645.8 million kw hr.

These figures show conclusively that steam as a generator of power, to say nothing of its other uses in industry, is maintaining its dominant position in the field.

Looking to the future, it is not likely that thermal efficiencies of internal combustion engines will be increased substantially over present practice; steam turbine and engine efficiencies may be increased some by more extensive use of high-pressure high-temperature steam; hydro turbines are near their upper limit of efficiency. Because of mass production for war purposes, both Diesel engines and steam turbines may be reduced in manufacturing costs. The development of more generally applicable heat recovery equipment for use with Diesel engines is a factor which may have a deciding influence on choice of power generating units.

In designing and operating a power plant, engineers must not neglect to consider all available types of power generating units nor other power sources, since the specific services required and local conditions should, for economic reasons, dictate the choice of equipment and its method of operation. That choice in many instances is found to be a combination of units—steam and Diesel, steam and hydro, hydro and Diesel, generated and purchased power. The possibilities along this line are only beginning to be explored among plant executives.

George E. Andrews

THE PASSING of our good friend and associate, George E. Andrews, takes from the family of Technical Publishing Co. a helper who will long be remembered for the cheer and unselfish good will which radiated in his presence. His hosts of friends in the field of power equipment advertising will feel the loss of his counsel in publicity affairs, but more deeply the warm friendship that was his for men of good intent. His was a life, the principle of which we could well emulate.

Deterioration and Maintenance

The rapid deterioration of the stacks and interior gas passages of boiler plant equipment presents a serious problem in large power stations. It is even more serious in these times when there are labor and material shortages. This timely discussion of the subject by Mr. Pearson tells how these problems are being met by one of the country's large utility systems, how the interior passages of the cinder catchers, flues and stacks are protected against the corrosive action of the flue gas by means of cement linings and how well these linings stand up under severe service. The experience of the Consolidated Edison Co. of New York in this work should be of great value to other plants and systems.

By S. J. Pearson

Assistant Engineer, Mechanical Engineering Dept.
Consolidated Edison Co. of New York, Inc.

THIS PAPER is a report on the deterioration and maintenance of structures and equipment in plants operated by the Consolidated Edison Co. of New York, Inc. Corrosion caused by flue gas and ashes has always been a serious item in power plants and it is more so in these times of maintenance labor and material shortages. Outages of equipment service for repairs are almost impossible to arrange in plants that are now required to operate continuously at near capacity loads. Cinder catchers, flues, steel and brick stacks, electrical precipitator concrete collector plates and ash hoppers and pockets are focal points of deterioration in power plants. The first three items will be discussed at this time.

Cinder Catchers at Hell Gate Station

The cinder catchers at this station are the so called "wet type". As shown on the sketch, the unit consists of a ¾ in. thick steel pan 34 ft long, 7 ft wide and about 3 ft high to which inlet and outlet flues are connected. During operation, the pan contains approximately 2 ft of water. The flue carrying the gas from the boiler to the cinder catcher directs the gas downward against the surface of the water. The gas flows over the water, strikes the far side of the pan and is then drawn upward toward the stack. The impingement of the gas against the water plus its deceleration as it expands from the flue into the large cinder catcher compartment causes deposition of solid material into the water, hence the name. The water in the pan is periodically drawn off and the ashes are sluiced into pipes and carried to an ash pocket.

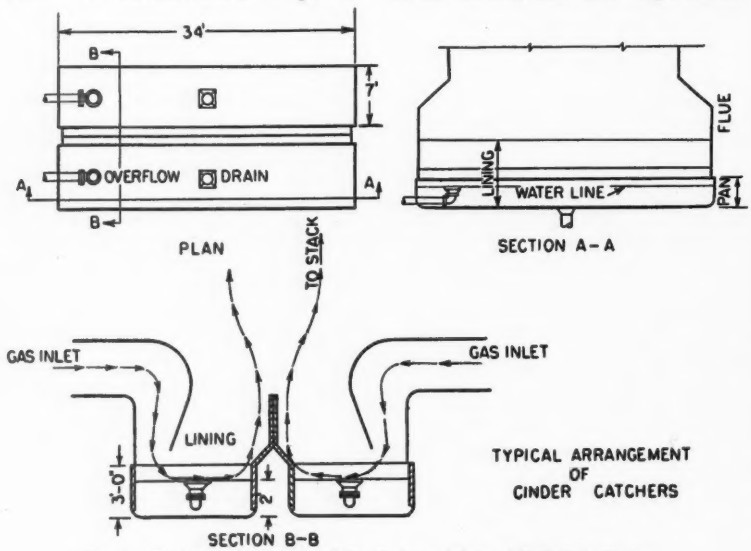


Fig. 1. Typical arrangement of the cinder catchers at Hell Gate Station.

The temperature of the gas is about 300 F in eighteen cinder catchers and about 525 F in the other six. The temperature of the water in the pan is about 100 F. This means that within a vertical distance of a few inches, the steel pan walls are subjected to a temperature gradient of 200 in the former units and 425 F in the latter with accompanying severe stresses and strains. At peak boiler loads, the gas passes over the surface of the water at such a high velocity that slugs of cool water are picked up and thrown against the hot steel. The stress produced by this thermal shock added to the stress already in the steel due to the sharp gradient of temperatures, soon cracks the steel pan and flue plates.

The water in the pan is salt river water and contains, after a short period of operation, sulphurous and sulphuric acids in the amount of 100 ppm and sulphates, as SO_3, in the amount of 1300 ppm. This corrosive mixture oxidizes the steel along a belt about 3 in. high just above the water line and the entire length of the exit side of the pan. The abrasive fly ash and cinders in the gas stream wear away the soft rust scale as quickly as it forms. This continuous cycle of corrosion and erosion cuts a slot through ¾ in. steel plate in three or four months of operation.

In many instances where de-

# of Power Plant Structures

terioration of metals appears to be caused solely by abrasion, in reality abrasive damage would not occur if rust scale had not first been formed. In this particular case, either condition acting outside the influence of the other would be ineffectual compared with the damage caused by the two working together. The corrosive conditions are practically the same at one foot above the water surface as at three inches, yet the damage at one foot is not nearly as great because the gas is flowing parallel to the plate at this point and its abrasive effect is not as great as at the lower level. The conditions are reversed in the flue on the boiler side of the cinder catcher. Very little damage occurs here because the hot gas, although laden with abrasive cinders and fly ash, is not corrosive.

Deterioration of the cinder catcher occurred in two forms. The greatest damage appeared on the exit wall in a space of about two feet above the water surface. In this area the ¾ in. plates became slotted, cracks appeared at welded joints and a severe general corrosion left the plates pitted and thin. Replacement of this section of the exit wall was required at intervals of three to six months depending upon the severity of service on the unit. The second form of damage was a general corrosion of all the remaining surfaces of the cinder catcher pan and the flue above the pan on the exit wall. This was relatively unimportant compared to the damage described above.

Fig. 2. Typical deterioration of pan wall on exit side of cinder catches. Note the trenching of the steel plate at the water line

Copper, lead and various alloy steels had been tried at the critical section with indifferent results. History of the maintenance of the units definitely indicated that a metal lining was not the answer.

With the exception of the water in the pan, the conditions in the cinder catchers are similar to the conditions found in stacks. Concrete had proved to be a good material for stack construction and lining. If the thermal shock which occurred in the cinder catcher at peak loads could be eliminated, it seemed that a dense, controlled concrete, reinforced to form a composite section with the steel plate of the pan and flues, would provide a suitable lining.

The cinder catchers were accordingly adjusted to eliminate water slugs at peak boiler loads. After tests were made on various cements and aggregates, a one to three and one-half mix of calcium-aluminate cement and silica sand was chosen. The reinforcing con-

Fig. 3. Typical repairs required on exit wall of cinder catcher prior to the use of concrete linings

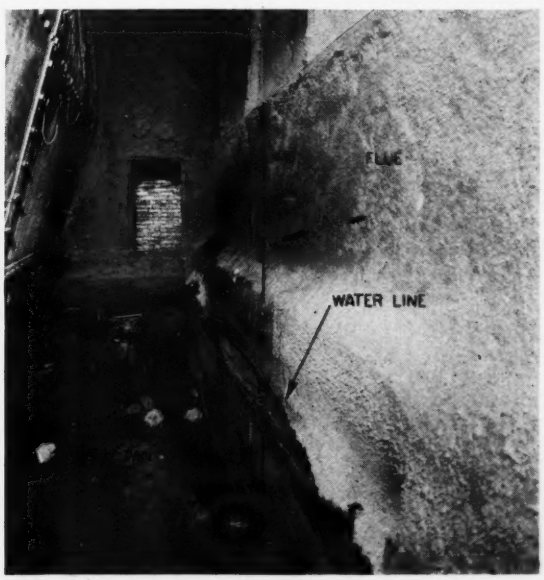


Fig. 4. Condition of concrete linings after one year of service. Note the accumulation of incrusted fly ash at the water line and the absence of erosion

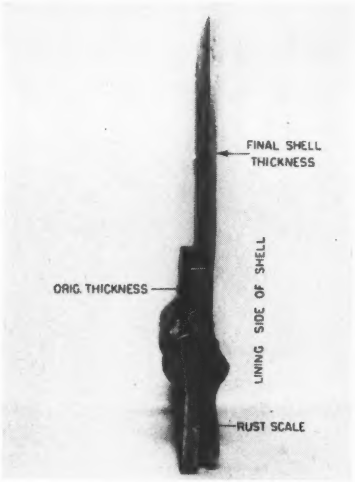


Fig. 5. Edge view of piece of horizontal joint removed from one of the brick-lined stacks of Waterside No. 2. Notice the cross-section of the rivet and the accumulation of rust scale

Fig. 6. View of the inside surface of a piece of horizontal joint removed from a stack at Waterside No. 2. Note the corroded rivet heads and the uniform deterioration over the plate surface

sists of 3 by 3 in. mesh, No. 10 by No. 10 wires fastened to ½ in. round reinforcing rods with tie wire. The rods were welded to blank nuts which were in turn welded to the pan and flue plates. The mesh was located 1¼ in. from the plate or in the center of the lining. The steel was thoroughly cleaned and just prior to placing the concrete the mesh and steel plate were sandblasted. The concrete was placed pneumatically with a "Cement Gun". The 2½ in. thick lining was installed on the side walls of the pan and also on the flue above the exit side of the pan to a height of about four feet. After the concrete was placed, it was kept wet continuously for three days.

It is extremely important that the concrete lining be dense and impervious to prevent gas and liquids from penetrating into the concrete. These characteristics are acquired by using a low water-cement ratio and by eliminating air pockets during placement. Gunite, which is concrete applied with the "Cement Gun", satisfactorily meets these requirements.

The results obtained with this lining have been gratifying. After one year's service, the concrete lining has suffered no worse effects than hair line cracks. The steel plate behind the lining and the reinforcing mesh in the concrete were still clean. The concrete, which had been exposed to 550 F and to the sulphurous and abrasive gas stream during this period was so hard that it was necessary to use a heavy type pneumatic hammer to penetrate it. It is significant that whereas the steel had become slotted at the water line, the concrete lining is unaffected. This proves that the abrasive effect of the flue gas is small when not preceded by corrosion and softening.

Linings have been installed in all twenty-four of the cinder catchers in this station and maintenance repairs on this equipment have been practically eliminated.

It has been conservatively estimated that the annual saving in maintenance costs is in the order of $40,000. In addition to this saving, there has been a considerable improvement in station efficiency due to fewer outages of boiler plant equipment.

Flues

Flues between boilers and stacks are usually not troublesome so far as maintenance is concerned if they remain inside of the building and are not exposed to outside temperatures. Whenever a flue leaves the protection of the boiler house, even though it is protected with an insulating cover, its condition should be watched carefully. An investigation may reveal a disturbing diminution in the original flue plate thickness.

The greatest deterioration will occur on the surface of the flue where a combination of corrosive and erosive conditions exist. At Hudson Avenue Station the flues rise from the cinder catchers into a common flue above the roof. Although covered with four inches of rock wool insulation and asphalt waterproofing, the top portions had become almost paper thin in places due to corrosion and the scouring action of the cinder bearing gas. At East River Sta-

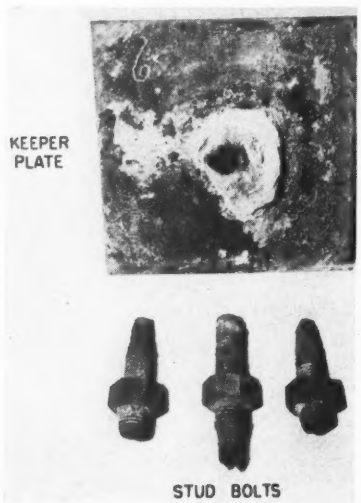


Fig. 7. Sample stud bolts and keeper plate that supported the asbestos block linings in stack No. 1 at East River. Note the corrosion of the bolts where they were welded to the shell

TABLE I—Tension, Compression and Soundness Tests on Cement Mortars Cured at Room Temperature and at 600 F

	Portland Cement Mortar Method of Curing			Calcium-Aluminate Cement Mortar Method of Curing		
	A	*B*	*C*	*A*	*B*	*C*
TENSILE STRENGTH Pounds Per Sq Inch Av of 3 Specimens	280	295	270	400	430	380
COMPRESSIVE STRENGTH Pounds Per Sq Inch Av of 3 Specimens	1970	2030	1870	5200	5330	3400
SOUNDNESS	....	Satisfactory	Satisfactory	....	Satisfactory	Satisfactory

METHODS OF CURING

Method A—Cured one day in moist cabinet, 5 days in ordinary air and one day immersed in water.

Method B—Cured one day in moist cabinet, 34 days in ordinary air and one day immersed in water, except the soundness specimens were not immersed in water.

Method C—Cured one day in moist cabinet, 6 days in ordinary air, 28 days in oven at a temperature of approximately 600 F and one day immersed in water, except that the soundness specimens were not immersed in water.

tion the flues were not lined either inside or out and the plates have become thin. Here corrosion was the main damaging agent with abrasion contributory in only a minor role.

The damaged flues at the stations mentioned above were repaired by installing a 1½-in. thick pneumatically placed concrete lining, reinforced to form a composite section with the steel flue plate. No replacement of the damaged flues was made. Patch plates were welded on the outside surface over holes and portions too thin to permit the welding of reinforcement lugs on the inside surfaces. Exterior insulating coverings were removed.

This repair procedure saves the labor and expense of rebuilding the flues, saves steel plate which is high on the critical material list, eliminates vibration and provides a protective lining which prevents further deterioration. Installing the lining is quicker than rebuilding the flues and requires a shorter outage period. An added advantage is the insulating effect of the lining on the outside surface temperature. Paints endure longer on the cooler surfaces.

Calcium-aluminate cement is used where the conditions of temperature and deterioration are severe and where a short outage period prevents proper curing.

This type of lining was inspected several months after its installation during which time it was subjected to hard continuous service. No damage was found, not even hair line cracks in the concrete.

Steel Stacks

Fifty-one steel stacks at Consolidated Edison Company plants have been examined in recent years. The program of investigation was begun after four stacks at one of the generating stations were removed as part of a general modernization project. These stacks were about 30 yr old and deterioration was expected, but the steel shells behind the five inch lining of brick and mortar were so severely corroded that a company-wide program of stack examination was started.

Many sizes and types are represented. Forty-two are self-supporting, 9 are guyed. When the examinations started, 34 were lined and 17 were unlined. Some of the latter have since been lined. The bottom diameters range from 5 to 31 ft and the top diameters range from 5 to 22 ft. Heights vary from 100 to 300 ft.

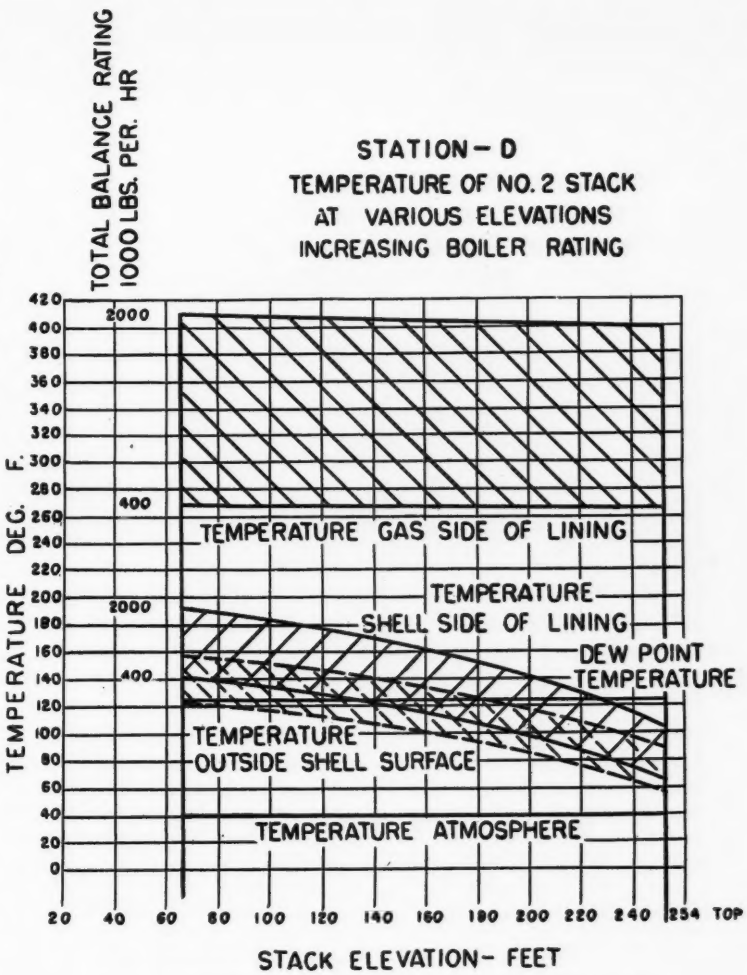


Fig. 8. Temperature of No. 2 stack at East River at various elevations

The work proved to have an element of suspense because, until each examination was finished, it was not known whether a ten thousand dollar repair job was necessary or a clean bill of health could be given. As expected, most of the lined stacks were in good condition although some corrosion and reduction of shell thickness were found in all of them. One of the lined stacks required the removal of the top half, another required replacement of the lining. Four unlined stacks required replacement of top sections and practically all indicated that a lining was not only necessary, but economically worthwhile.

Corrosion of the steel shell on all of the lined stacks and particularly on the two stacks mentioned above was due to the porosity of the lining. A lining to be effective must be impervious to flue gas. If it is porous, the gas penetrates to the cool steel shell where condensation of the sulphur constituents occurs and the corrosion begins.

The four stacks, which were removed at Waterside No. 2 during modernization, were 232 ft high, 22 ft in diameter and were lined with 4 in. of common brick backed up with 1 in. of cement and sand mortar. Although the lining was in good condition after 30 yr of service, the steel was deteriorated to almost zero thickness over large areas in the top sections.

Stack No. 1 at East River is 254 ft high and 22 ft in diameter. It was lined with an asbestos block one inch thick backed up with one inch of asbestos and cement mortar. The blocks were four feet square and were held at the corners by 6 by 6 by ⅛ in. keeper plates which were in turn secured by means of ½ in. stud bolts welded to the steel shell. After 7 yr of service, some of the

Fig. 9. (Left) Open joints and corroded step iron at the top of the west stack at Port Morris. Note that the diameter of the step iron has deteriorated from the original 7/8 in. to a thin wire

Fig. 10. (Above) Fissures and open joints at the top of a radial brick stack at Port Morris

blocks at the bottom of the stack had buckled from the heat causing some to fall out. The stud bolts in the upper half had corroded to practically nothing at the point behind the lining where they were welded to the shell. Rust scale was present on the shell over most of the area in the upper half. The keeper plates, nuts and ends of the bolts on the gas side of the lining were not corroded. It was only necessary to touch the bolts with a wrench and they parted from the shell. This lining was removed and a 2½ in. reinforced gunite lining of Portland cement and sand was installed. After one year's service with temperature of the flue gas reaching 425 F at peak loads, no signs of damage were visible on this lining.

Stack No. 2 at 66th Street, 230 ft high 15 ft in diamater at the bottom, 12 ft in diameter at the top had been in service for 35 yr. It was lined with an independent brick wall having a width of 22 in. at the bottom and 4 in. at the top. The brick is in contact with the shell throughout most of the stack height. Although the lining was in good condition, the steel shell had become thin in the top 100 ft. This section was removed and rebuilt.

The stack at Burling Slip is 303 ft high and 22 ft in diameter. It had been in service for 10 yr at the time of the examination and was unlined. A reduction of ⅛ in. had occurred in the steel shell midway in the height and the rivet heads on the interior surface were reduced in size. Assuming the same rate of deterioration as had occurred in the past and considering the additional load due to the lining, the shell would be overstressed if the installation of a lining was delayed more than one year. A 2½ in. reinforced gunite lining of Portland cement and sand was installed.

The stack at Kips Bay is 240 ft high, 22 ft in diameter and had operated for 14 yr without a lining. During this period, high grade pulverized coal was burned and the load on the boilers was continuously high with only a moderate slackening during the summer months. Notwithstanding these unfavorable conditions it was surprising to find this stack in excellent condition with only a slight reduction in shell thickness and interior rivet head size. Peri-

TABLE II—Results of Tension, Compression and Abrasive Tests on Cement Mortars

Kind of Aggregate	Mix—Proportion by Volume Aggregate	Cement*	Water	Tensile Strength Pounds per Sq In. Average of 3 Specimens Age 28 Days	Compressive Strength Pounds per Sq In. Average of 3 Specimens Age 28 Days
Trap Rock	3.0	1.0	0.95	555	6780
Haydite	3.0	1.0	1.02	420	4650
Gr. Ott. Sand	3.0	1.0	0.80	440	6770
Carbon Brick	3.0	1.0	1.18	395	4300
Carborundum	3.0	1.0	0.82	475	7880
Vermiculite Gr. Ott. Sand	1.5 1.5	1.0	1.61	160	800

Resistance to Abrasion

	Original Wt of Specimen Grams	Loss in Wt Grams**	Ratio Loss of Wt to Orig Wt
Trap Rock	1309	32	2.45
Haydite	1010	38	3.76
Gr Ott Sand	1178	36	3.06
Carbon Brick	1001	44	4.39
Carborundum	1420	30	2.11
Vermiculite Gr Ott Sand	1043	111	10.62

*All specimens were made with calcium-aluminate cement.

**Amount of material removed by 10 kg of 20-30 mesh Ottawa sand in an air blast at 40 psi air pressure.

odic yearly examinations will be made in order to detect any changes that may occur. Eventually a lining will be installed.

It has been the practice in the past not to line the smaller steel stacks of 5 or 5½ ft in diameter. Consequently, every two or three years the top portions of 25 to 50 ft require replacement. A study of costs showed that a 1½ in. reinforced gunite lining could be installed at approximately the cost of one shell replacement job. A lining in these stacks, where repairs are required at regular short intervals, is not only economical in regard to maintenance but it eliminates the waste of equipment service time, while repairs are being made.

A reinforced gunite lining, installed to form a composite section with the steel shell, is considered an excellent protection for steel stacks. To mention a few of its advantages, it is comparatively light; it reinforces the shell against o v a l i n g and vibration, and it provides a monolithic lining that is dense and impervious. Gunite requires only a short outage to install and it may be varied in composition and thickness to meet various conditions. In this connection, it is the practice in this company to make gunite linings 2½ in. thick in large diameter self-supporting stacks and 1½ in. thick in the smaller stacks especially where guys are used to take the wind load.

Fig. 11. Removal of the top ten feet of the damaged west stack at Port Morris

Portland cement is used where corrosion characteristics of the flue gas are not severe and the maximum temperature does not exceed 450 F. Calcium-aluminate cement is used where corrosion is severe or where the temperature exceeds 450 F. Silica sand is used for aggregate where the maximum temperature is less than 600 F. Haydite is used where the temperature exceeds 600 F.

Temperature Study of Stack

In order to understand more clearly why the steel shell behind a brick lining deteriorates and why the worst corrosion occurs consistently in the upper half of brick lined stacks, a temperature study was made on stack No. 2 at East River. The height is 254 ft, the diameter is 22 ft and the plate ranges in thickness from ¾ in. at the bottom to 7/16 in. at the top. It is lined with 4 in. of common brick with 1 in. of cement mortar between the brick and the steel shell. The temperatures were taken over a full range of boiler loads on: 1. the outside surface of the shell; 2. the shell side of the lining; and 3. in the gas stream, 6 in. from the inside surface of the lining. Fig. 8 shows the variations of temperature at increasing boiler rating. Interesting to note is the uniformity of gas temperature from the base to the top. The high temperature of the gas at the top accounts for the good condition of steel members at this location framed across stack diameters and exposed to the gas for many years. Reference is made here to a soundproofing frame in one stack and an unused elevator frame in another. There was no measurable reduction of this steel although the ash laden gas passed it at approximately 4000 ft per minute; more proof that unless corrosion occurs, erosion of steel by flue gas is insignificant.

The presence of sulphur deposits behind the lining and the corrosion of the shell on most brick lined stacks establishes the fact quite definitely that the flue gas does penetrate brick linings to the shell. The middle set of curves on Fig. 8 is based on temperatures recorded on the shell side of the lining for the full range of boiler ratings. The dew-point temperature of the gas in the stack has been determined at 125 F. A line drawn horizontally through this temperature intersects the low load side of the band at the stack elevation of 132 ft and the high load side at 225 ft. The gas in the vicinity of the shell, therefore, is cooled below the dew-point temperature over the area of the shell above the elevation of 132 ft at 400,000 lb per hr rating and over the area of the shell above the elevation of 225 ft at 2,000,000 lb per hr. As the boilers fluctuate between low and peak ratings during a day's operation, gas behind the lining in some portion of the top half of the stack is always being cooled below dew-point temperature with resulting condensation of the sulphur constituents close to the shell.

The data provided by the temperature study on stack No. 2 at East River explain conditions found in all of the 33 brick lined stacks that were examined. Rust scale was present behind the lining in all cases and deterioration was greatest in the top half of the stacks with little or no deterioration in the bottom half.

Stack Examination Procedure

A routine procedure is followed on each stack examination. An inspection is first made on the exterior surfaces with attention to the condition of: 1. the shell, 2. the ladder, 3. the platform at the top and 4. the steel or cast iron channel which supports and acts as a canopy for the top of the brick lining. (Repairs are often required on the top of the ladder, the platform and the protective channel. The outside surface of the shell is periodically painted and no significant reduction of the shell thickness occurs from this side.) After this preliminary examination is made, each stack ring is gauged for thickness along a vertical line the full height on the prevailing wind side of the stack. A check examination is made on the opposite side if conditions warrant it. This completes the examination on a lined stack; if the plate is in good condition, it is assumed that the lining is not damaged. If the plate is thin and overstressed, the lining will be removed anyway as part of the shell replacement job. The procedure is extended in the case of an unlined stack to include the removal of a rivet at the elevation where the reduction in shell thickness is greatest in order to determine the loss in size of the interior rivet heads. Interior examination is made from a boatswain's chair in unusual cases if conditions require it.

Brick Stacks

Seven radial brick stacks have been examined in recent years in

addition to the steel stacks already described. They range in heights from 100 to 212 ft and in bottom diameters from 12 to 22 ft with wall thickness varying from 26 in. at the bottom to 10 in. at the top. Six of the seven brick stacks required repairs.

Damage found on these stacks was caused by one or a combination of the following three conditions: 1. lightning, 2. flue gas and 3. intermittent operation. Lightning is the least common offender. On the rare occasions it strikes destructively, it leaves fused lightning arrestor terminals and cracked brickwork. Flue gas contains corrosive elements which soften the mortar and crack the brickwork after a long period of service. Intermittent operation of the boilers on the stack produces the same results only more quickly and destructively.

Effects of Intermittent Operation

Intermittent operation affects a stack in several ways. When it is cold and the boilers are suddenly fired, a temperature differential of 100 to 200 F may be set up between inside and outside surfaces and between vertical portions of the brickwork. Resulting stresses are relieved by cracking. During a period of idleness a rainstorm may saturate the porous brick and mortar and a sudden drop in temperature below the freezing point causes the frozen mortar and brick to spall and crack. In common with brick lined steel stacks, the more transitions from cold to hot and hot to cold, the greater will be the concentration of moisture and sulphur compounds in the brick and mortar due to the condensation of the flue gas when the temperature drops below the dew point.

Damaged brickwork on stacks may be attributed to the presence of sulphates which react with the free calcium hydroxide in Portland cement mortar to form calcium sulphate. Formation of calcium sulphate is accompanied by expansion which crumbles the mortar and produces fissures. It is the practice in this company to point up inside joints with calcium-aluminate cement.

Repairs on a radial brick stack usually consist of replacing cracked bricks, raking out crumbled mortar from joints on the inside and outside surfaces and refilling them, replacing lightning arrestor terminals and leads, replacing corroded step irons and installing iron bands around the stack column where cracks are severe. Deterioration and the effects of lightning and frost usually occur near the top. Occasionally an entire top portion must be removed and rebuilt.

Caps consisting of steel frames with canvas covers have been installed on stacks which are operated only periodically. These covers are designed so they may be removed quickly in case it is necessary to fire the boilers at short notice.

Conclusion

The writer was assigned the task of making a comprehensive study throughout the Consolidated Edison System of the extent and cause of the damage to the structures and equipment covered in this report, and to recommend corrective measures.

Field and laboratory tests were made to investigate, measure and evaluate the physical and chemical agencies contributing to the damage. Research and experiments were next undertaken, leading to the pneumatically placed reinforced concrete lining procedure.

The author wishes to express his appreciation for the helpful cooperation of R. P. Hooper, V. E. Hagan and Joseph Cifuentis in preparing laboratory and field data relative to this work. The manufacturer of the "Cement Gun" equipment, the makers of Portland and calcium-aluminate cements were very helpful in determining the best adaptability of their materials. Thanks are extended to certain engineering and utility companies throughout the country who generously supplied information on their experience with gunite stack linings.

The author attaches a list of books and articles which he has found pertinent to this work.

Lea and Desch—The Chemistry of Cement and Concrete

Bauer—Plain Concrete

Portland Cement Association — Effect of Long Exposure of Concrete to High Temperature

C. R. Platzman—Special Cements

R. C. Bickmore—Concrete versus Water

W. Watters Pagan—Wind Design by Aerodynamic Principles (Eng. News Record, March 15, 1934)

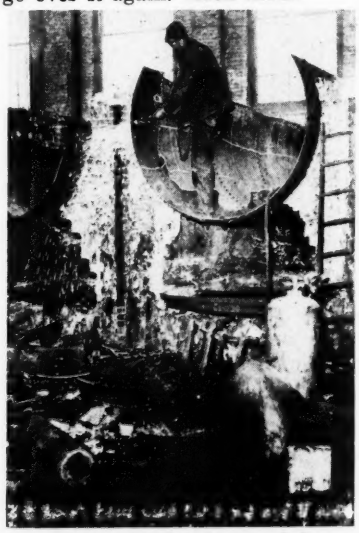
Gonnerman and Shuman — Tests of Plain Concrete (Proceedings A.S.T.M. Vol. 28, 1928 Technical Papers)

MORE SCRAP

Needed for the "Big Push"

THE "BIG PUSH" is on in Europe. We're going to need 1,000,000 *extra* tons of heavy, melting scrap during the last six months of 1943. And if the coal situation continues to threaten, we may need even more.

So, even if you have already made a thorough search for dormant scrap, *look again!* Maybe you missed one item. If you have made yourself a scrap check list as suggested on page 84, January issue, go over it again. *Look hard!*



If it hasn't been used for 3 mo and if someone can't prove it's going to be used in the next three—sell it—or scrap it!

Here's a point to remember. Some changes have recently been made in CMP regulations (see July issue, page 102). Perhaps your industry now has a better allocation number and you can get MRO supplies now that you couldn't get last January.

So look again for scrap! If any blast furnaces have to shut down because of fuel shortages, we must still maintain steel production at maximum. That means that under the worst conditions, instead of 50 per cent scrap, we might have to use 75 or 100 per cent scrap for steel-making. Look again for:

- Engine, turbine, pump parts
- Boiler drums and parts
- Unusable old shafting, railroad rails, etc.
- Old building steel
- Unusable meters and instruments
- Condensers, heaters, stacks, flues, ducts
- Electrical equipment including cable and buses

Heat Economy in Large Hotels

For most engineers who supervise a hotel heating plant the economy in the boiler house appears to be the most essential task. Yet it has been shown in two preceding articles* that the effort to regulate the heat supplied to meet variations in outside temperature, to maintain efficiency in heating water and to secure economical use are equally important. The purpose of this article is to give some of the most important details which have to be watched in the supervision of a power plant serving a hotel

by Paul L. Geiringer, ***Licensed Professional Engineer, Newtonville, Mass.***

IN ORDER to clarify some of the suggestions proposed here, I would like first to outline what I consider the ideal hotel plant. It will then be easier to compare the existing plant in any hotel with the layout described and to find ways and means to improve the efficiencies at the time when the war restrictions will allow such a move. It is never too early to recognize the faults of a plant, because it requires considerable time for an owner to translate his notion into reality and to plan improvements. Many of the ideas might even be carried out right away, as their execution involves no vital materials used for war but involves a better utilization and application of personnel and machinery.

Ideal Plant Layout for Hotel

The most economical layout for a hotel plant is usually a combination of equipment for the production of heat and power. This general rule should be followed in all circumstances where adequate financial capital is available, where the production of power is not hampered by laws, or where the space in the basement of the hotel is not so limited that the room required by the power plant must be utilized for other departments of the hotel, such as kitchen, air conditioning plant, elevators, etc. If power production is out of the question, careful investigation should be made of the possibilities of getting the supply of both power and heat from a utility plant to avoid any home production. If both services are provided from outside sources, the advantages resulting from the reduction in personnel, expenses for maintenance, the avoiding of the dirt caused by the fumes, the unloading of coal and the loading of ash, and finally the financial savings are often so great that in spite of the apparently exceedingly high prices, the complete utilty service is more favorable than home production.

Generally speaking, however, the best plan for a hotel is to install its own combined power and heating plant. Such a plan has to overcome one considerable difficulty, that is to secure an adequate amount of water for cooling and condensing purposes. The heat and power requirements do not coincide either in time or in quantity and no relation can be found between these demands. The various solutions which have been tried to equate the demands by means of steam or power accumulators (storage batteries) have more or less failed and cannot be considered as satisfactory solutions. During the greater part of the year, many plants exhaust steam to atmosphere which is certainly not an efficient arrangement. The best solution is to use a condensing unit during the time when steam or heat requirements are low, or, if condensing water cannot be provided, to install a Diesel engine. Sufficient space is seldom available for the installation of water cooling equipment. A bleeder turbine designed also for operating condensing, or a two cylinder combination back-pressure and condensing steam engine, or turbine combined with a Diesel engine are common solutions. The exhaust pressure should never exceed 40 psi gage but in most cases it can be held at about 10 psi. In larger plants where steam must be conveyed considerable distances the selection of a higher pressure might provide some advantages.

The boiler pressure in these cases should be 220 to 250 psi, superheating the steam to about 600 to 630 F. If a lower exhaust pressure is used the boiler pressure can be reduced to 180 to 200 psi. This latter pressure will generally suffice for plants of medium size if the steam is superheated to 600 to 650 F total temperature. A water tube boiler is preferred as it can be cleaned easily and steams quickly. Economizers should be used in any case but not air preheaters because the complications encountered with this equipment are too great for a hotel power plant. The water treatment plant should be as simple as possible and if condensate is used as feedwater only a surface condenser should be considered in order to reduce the water treating expense. Lime-soda treatment is used extensively and should be given careful consideration along with other systems. Water treatment in the boiler alone is often the simplest solution.

If the load per unit is under 200 kw, a steam engine will prove superior. If sufficient cooling water cannot be provided, substitution of a Diesel engine for the condensing cylinder of the steam engine is usually the best solution. The cost of a kilowatt-hour produced by a Diesel engine is lower than when produced by a steam unit exhausting to atmosphere. Cooling water from the cylinders of the Diesel can be used for the hot water service of the hotel, so during the summer months it is possible to serve the whole house from the Diesel engine alone, thus supplying both heat and power from one unit. At least two units are necessary for a hotel and one of them should be a Diesel engine. During the summer months as well as nearly all the other months of the year and also during the night, the operation of the Diesel engine will prove economical.

Boiler and Fuel

In normal conditions, oil fuel should be used provided the price

*October 1942 issue page 80 and December 1942 page 79.

HOTEL_____ **HEATING AND POWER PLANT WEEKLY REPORT** NO.... WEEK FROM_____ TO_____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
TIME						BOILER LOAD		ASH						BLED STEAM			POWER STEAM TO CONDENSER								
DAY	DATE	BOILER NO.	TIME IN SERVICE HR	FUEL BURNED LB. COAL	WATER EVAPORATED LB	STEAM PER SQ.FT. HEATING SURFACE LB.	COAL PER SQ.FT. GRATE SURFACE LB.	LB.	% OF COAL FIRED	EVAP. PER LB. COAL LB.	COAL PRICE PER TON $	DAILY FUEL COST $	FUEL COST PER 1000 LB. STEAM $	CONSUMPTION 1000 LB.	FUEL COST AT LIVE STEAM RATE $	FUEL COST AT ADJUSTED RATE $	AMOUNT 1000 LB.	FUEL COST $	FUEL COST FOR TOTAL POWER STEAM $	FUEL COST OF STEAM FOR AUXILIARIES $	DIESEL COSTS FUEL AND LUBRICATING OIL $	STEAM-ENGINE POWER PRODUCED KW-HR.	DIESEL ENGINE POWER PRODUCED KW-HR.	POWER PURCHASED KW-HR.	REMARKS
SOURCE OF DATA	CALENDAR	LOG SHEET	LOG SHEET	SCALES	FEEDWATER METERS	COLUMN 6 ÷ BOILER HTG. SURFACE	COLUMN 5 ÷ SOFTGRATE SURFACE	LOG SHEET	COLUMN 9 ÷ COLUMN 5 X 100	COLUMN 6 ÷ COLUMN 5	FUEL PRICE RECORD	COLUMN 5 X COLUMN 12 ÷ 2000	1000 X COLUMN 13 ÷ COLUMN 6	METERS	COLUMN 14 X COLUMN 15	COLUMN 16 X R*	CONDENSATE METERS	COLUMN 18 X COLUMN 14	COLUMN 16 - COLUMN 17 = COLUMN 19	COLUMN 13 - COLUMN 17 = COLUMN 20	LOG SHEET	METERS	METERS	METERS	
SUN.																									
MON.																									
TUE.																									
WED.																									
THU.																									
FRI.																									
SAT.																									
TOTAL																									
AVE.																									

APPORTIONMENT OF PLANT COSTS

STEAM GENERATION	DOLLARS	STEAM POWER GENERATION	DOLLARS	DIESEL ENGINE POWER GENERATION	DOLLARS	PURCHASED ELECTRIC POWER	DOLLARS	UNIT COSTS AND RATIOS	DOLLARS
FUEL COST (COL.13)		FUEL COST OF POWER STEAM (COL.20)		FUEL OIL COST		COST OF OUTSIDE POWER (COL.25 X RATE)		COST OF LIVE STEAM PER 1000 LB (ITEM 27) $	
WATER COST		ENGINE ROOM WAGES		LUBRICATING OIL COST		WAGES (APPORTIONED)		COST OF BLED STEAM PER 1000 LB (ITEM 27 X R*) $	
BOILER HOUSE WAGES		SALARIES (APPORTIONED)		WAGES (APPORTIONED)		SALARIES (APPORTIONED)		COST OF HEATING STEAM PER 1000 LB (ITEM 27 X r*) $	
SALARIES (APPORTIONED)		AUXILIARY MATERIAL COST		SALARIES (APPORTIONED)		MATERIALS		COST PER KW-HR. STEAM GENERATED ELECTRICITY (ITEM 29) $	
AUXILIARY MATERIAL COST		MAINTENANCE EXPENSES		AUXILIARY MATERIAL COST		MAINTENANCE EXPENSES			
MAINTENANCE EXPENSES		SHOP EXPENSES		MAINTENANCE EXPENSES		TAXES ON ELECTRIC EQUIPMENT		COST PER KW-HR. DIESEL GENERATED ELECTRICITY (ITEM 31) $	
SHOP EXPENSES		TAXES ON STEAM ELECTRIC POWER EQUIPMENT		SHOP EXPENSES		INSURANCE ON ELECTRIC EQUIPMENT			
TAXES ON BOILERHOUSE EQUIPMENT		INSURANCE ON STEAM ELECTRIC POWER EQUIPMENT		TAXES ON DIESEL EQUIPMENT		DEPRECIATION ON ELECTRIC EQUIPMENT		COST PER KW-HR. PURCHASED ELECTRICITY (ITEM 33) $	
INSURANCE ON BOILERHOUSE EQUIPMENT		DEPRECIATION ON STEAM ELECTRIC POWER EQUIP.		DEPRECIATION ON DIESEL EQUIPMENT		INTEREST ON INVESTMENT			
DEPRECIATION ON BOILERHOUSE EQUIPMENT		INTEREST ON INVESTMENT		INTEREST ON INVESTMENT		(32) TOTAL COST OF PURCHASED POWER		HOT WATER PER GUEST-DAY GAL. (ITEM 35)	
INTEREST ON BOILERHOUSE INVESTMENT		(28) TOTAL STEAM ELECTRIC GENERATING COST		INSURANCE ON DIESEL EQUIPMENT		(33) UNIT COST PER KW-HR. PURCHASED POWER (ITEM 32 ÷ COL. 25)		LB. STEAM PER AVAILABLE ROOM (ITEM 36)	
(26) TOTAL STEAM GENERATING COSTS		(29) UNIT COST PER KW-HR STEAM GENERATED ELECTRICITY (ITEM 28 ÷ COL. 23)		(30) TOTAL DIESEL POWER COSTS				LB. HEATING STEAM PER GUEST-DAY (ITEM 37)	
(27) COST OF STEAM PER 1000 LB. (1000 X ITEM 26 ÷ COL. 6)				(31) UNIT COST PER KW-HR. DIESEL GENERATED ELECTRICITY (ITEM 30 ÷ COL. 24)					

HOT WATER REPORT				FUEL PRICE		FUEL MOVEMENT					DEFECTS		ROOM HEATING REPORT					NOTES
DAY	HOT WATER CONSUMED 1000 GAL.	STEAM FOR HOT WATER 1000 LB.	LB. STEAM PER 1000 GAL. WATER	NAME OF COAL	PRICE PER TON AT THE MINE	PRICE PER TON AT THE BOILER HOUSE	DESCRIPTION OF FUEL	KIND	CLASS	SIZE	BTU/Lb	NOTE HERE ALL DEFECTS OBSERVED IN EQUIPMENT ON DAY FIRST SEEN		DAY	LB. STEAM USED A	TEMP. OUTSIDE DEG. F. B	TEMP. 65 - OUTSIDE C	LB. STEAM PER DEG. DAY (A ÷ C = D) D	
SUN.							BIN OR TANK NO.							SUN.					FOOT NOTE * TO DETERMINE R AND r: LET H_1 = HEAT VALUE OF 1 LB LIVE STEAM AS GIVEN IN STEAM TABLES MINUS THE HEAT IN THE WATER GOING TO THE HEATER; H_2 = HEAT VALUE OF 1 LB. BLED STEAM MINUS HEAT IN FEEDWATER GOING TO HEATER; h = HEAT VALUE OF 1 LB. HEATING STEAM MINUS HEAT IN FEEDWATER GOING TO HEATER. THEN: $R = H_2 \div H_1$ AND $r = h \div H_1$
MON.							WT. IN BIN SUNDAY A.M.							MON.					
TUE.							FUEL REC'D DURING WEEK							TUE.					
WED.							TOTAL							WED.					
THU.							OUTGOING FUEL BOILER NO. 1							THU.					
FRI.							OUTGOING FUEL - BOILER NO. 2							FRI.					
SAT.							OUTGOING FUEL - BOILER NO. 3							SAT.					
SUM.							TOTAL USED							TOTAL					
AVE.							WT. IN BIN AT END OF WEEK							MEAN					
(34) GUEST DAYS														36 LB. STEAM PER AVAILABLE ROOM					
(35) GAL. HT. WATER PER GUEST-DAY														37 LB. STEAM PER GUEST-DAY					ENGINEERS SIGNATURE

Fig. 1. Form for reporting weekly hotel heating and power costs

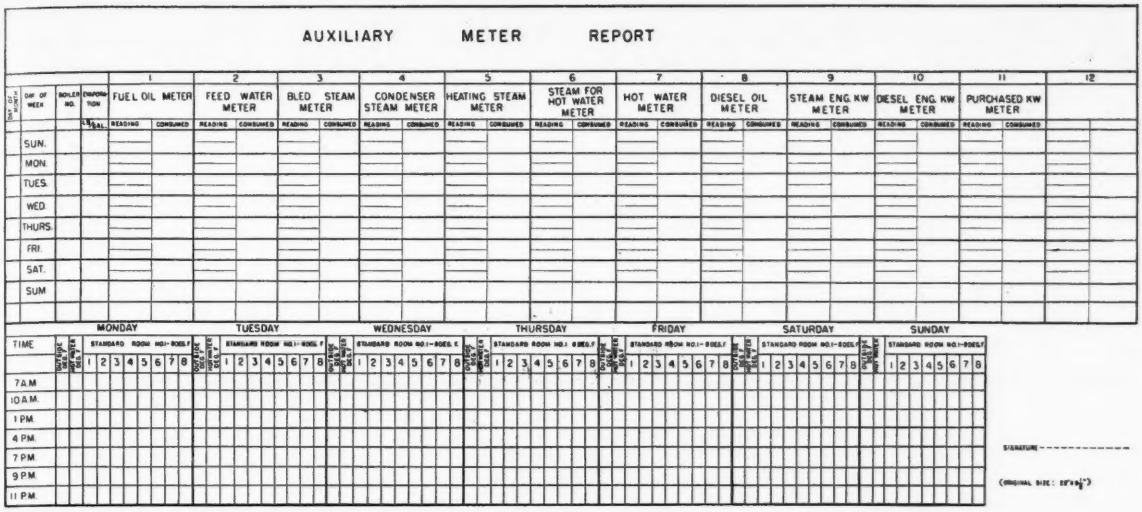


Fig. 2. Form for recording daily meter readings

of this excellent fuel is not much higher than that of coal. Only No. 5 oil should be employed and the minor discomforts in preheating the oil are largely equated by the savings obtained through the lower price. The greater cleanliness of oil compared with coal is of such importance to a hotel that fuel expenses even somewhat greater than with coal can be justified.

If solid fuel is burned, the smaller sizes of coke or soft coal, excluding dust, are well suited. Automatic coal firing equipment should be installed in any case.

Supervision of Power Plant

The steam cost should be calculated daily for each shift. It will be found that these figures vary somewhat from day to day and that even between the different shifts considerable differences exist. The exact checking of these figures is one of the best means of controlling the fuel consumption of the house. Furthermore, it enables us to select the fuel best suited for the boilers. The keeping of records of all the important phases of heat production and heat utilization provides the tool for supervising a plant. The steam produced has to be apportioned to the main points of consumption, i.e., the generation of power, the production of hot water and the room heating. In this way the cost per kilowatt-hour of electric power produced and that of a gallon of hot water at 140 F are ascertained. These figures—the cost per kilowatt-hour, the cost per gallon of hot water and the cost per 1000 lb of heating steam—are of major importance.

The quantity of heat required for space heating can be checked by comparing the daily figures with the outside temperature, taking also into account the size of the room to be heated. In this way the steam or amount of heat consumed per degree-day and per 1000 cu ft of space heated or sq ft of radiator surface is ascertainable. A rough check on the amount of hot water consumed can also be obtained by comparing this figure with the number of guests per week.

Only one report (a design of which is shown in Fig. 1) is required to keep track of the consumption. This report incorporates practically everything that is necessary to determine costs. It enables the engineer to calculate the steam and power costs, and it is accurate enough to compute the cost of steam used by the steam engine or turbine for power generation and of process steam. The entire form is self explanatory.

Keeping of this report does not require much of the engineer's time, especially if he has (as is usually the case) some trained help for reading the meters and for making the auxiliary report. Only one line of the main report has to be put in every day which will not take more than ½ hr and once a week the whole final calculation can be done within a maximum of 2 hr. The data received from this report are certainly of such importance to the engineer interested in his plant that he will want to spend the time required for the calculation of these figures.

The auxiliary report, as shown in Fig. 2, is preferably kept in a book of handy size, printed in such a way that the report is extended over both the left and the right pages so that the book can be taken directly to the meters and the readings entered immediately on the report.

This auxiliary report provides space for the entering of the temperature of the standard rooms. These readings of the temperatures should be taken every hour, but some hotels consider it adequate to check only every 2 or 3 hr. The frequency is an individual problem dependent upon the size of the house, exposure, etc. These columns can easily be extended to provide space for hourly enterings. If only three-hour periods are set up, a reading must be inserted for 9 pm as it is important to know the temperature of the house at this time when the pressure on the boilers is being slowly reduced and especially when it is the practice to bank the boilers for the night, and the temperature in the room may be allowed to drop. The outside temperature is equally as important as the temperature of the water and therefore these readings should be taken at the same time.

No computation has to be done by the firemen, except the calculation of the evaporation figure, which is so important and so easy to make that under all circumstances he should be sufficiently interested in the results of his work to make the additional effort.

It is clear that these two sample report sheets given in Figs. 1 and 2 cannot be shown adapted to the various ways in which different plants may be laid out. Generally speaking, it will be possible to use fewer columns and simpler reports. My intention was to show that it is possible to make an accurate computation with simple means.

A New Armature Winding Diagram

Part IV

This is the final installment of Mr. Taylor's article describing the principles and application of this new type of armature winding diagram. In this part, he applies the diagram to the layout of the unequally grouped coil a-c type of winding. This and the chorded winding considered in Part III in the July issue are the most general and the most interesting of the a-c armature windings. Both are important to electrical engineers and power plant operators

By WILLIAM T. TAYLOR

HAVING COVERED the application of the new diagram to basket, mesh and lap windings in the second part of this article and to the chorded type of winding in Part III, now in Part IV, we will consider its use in connection with the unequally grouped coil windings. This winding is so called because it has an uneven or unequal grouping of coils in the phase belts.

For phase windings of all types (particularly the fractional pitch type of winding of Part III, the unequally-grouped-coil type, and the fractional-slot and coil type) the reader is again reminded to keep well in mind the visualized phase-belts and the importance of knowing at a glance the phase-zone boundary top and bottom coil-side positions and their electrical degree relations, which are:

(top)	(bottom)	(top)	(bottom)	
0°	to 60°	and 180°	to 240°	for phase A winding
60°	to 120°	and 240°	to 300°	for phase B winding
120°	to 180°	and 300°	to 360°	for phase C winding

The importance of phase-belts is evidenced when we desire to extract the "simplified" winding table since such a table gives only the phase-zone boundary top coil-sides as seen along one vertical line (A-A′ Fig. 1), or over one circle (see A-A′ Fig. 1a), for phase A, and the same for B and C phases, respectively.

The number of slots determine whether a given iron core can be wound with an equal number of coils throughout or an unequal number of coils arranged to make up balanced phase-groups so far as voltage is concerned, or an equal number of coils per phase-group arranged so that certain coils are "killed" or slots emptied in order to make up balanced phase-groups so far as voltages are concerned. For balanced phases we may have to increase or reduce the number of active slots and/or coils by multiples of three for a 3-phase winding, i. e. multiples of one per phase for any phase winding. In the case of a cut-out stator coil from one of three phases, a 3-phase winding will operate quite satisfactorily provided it is single-series star connected and the voltage due to coil reduction is not less than about 10 per cent of the phase-to-phase voltage. These diagrams show all the best operating positions for cut-out coil conditions.

The unequally grouped coil winding is required to either improve the wave form by substituting a greater number of smaller waves or ripples for a few larger waves produced by the integral slot and coil full-pitch winding, or it may be the next best or quickest solution to that of a re-wind where the supply voltage has been changed. It may be required where a small increase or decrease in the number of coils will give the equivalent of more or less conductors, and it may be required where the core of a stator has been wound with more than one winding.

The same simple lap winding connection rules apply to the 2-layer integral slot and coil full-pitch and fractional-pitch windings as well as the integral-slot fractional-coil (full-pitch and fractional-pitch) windings referred to in this article; that is: (1) Coil-to-coil connections per phase and per pole are bottom to top; (2) Group-to-group (pole-to-pole) connections per phase are bottom to bottom; and (3) Group-to-group (pole pair) connections per phase are top to top.

Where the inherent pitch S/p is a whole or integral number we see that a fractional-slot condition cannot exist. The number of active coils per pole is C/p, number of coils per pole and phase is C/p Ø, and number of slot spacings coming between each "empty" slot is S/(S-C) in terms of C. Thus, for the ½-slot-step such as 2½, 3½, 4½.....x½ coils per pole-phase the "extra" or "empty" slot step is:

6-slot spacing for a 2½ slot step per pole-phase
8-slot spacing for a 3½ slot step per pole-phase
10-slot spacing for a 4½ slot step per pole-phase
12-slot spacing for a 5½ slot step per pole-phase
y-slot spacing for a x½ slot step per pole-phase

Writers briefly mention the number of coils in the various phase groups or the phase-group top coil-side numbers when talking of this type of winding, and due to this brevity it is questionable whether many readers understand how to make the necessary connections for a fully developed winding. Actually seeing the "order of coil grouping" as well as the *fully developed* winding connections is what the average reader wants. By seeing all these one knows definitely because every coil side, phase-lead position and electrical angle can be checked for accuracy. This is an advantage not only because seeing the real thing is believing, but because such a picture of a fully developed winding serves as a timely reference when facing a critical situation and need for temporarily operating a winding with one or more burnt-out coils.

One type of unequally grouped coil winding may show that certain slot-intervals are lengthened by the introduction of what may be called electrically-dead slots; another type may show that there are no electrically-dead slots and that slight phase-belt overlap occurs in the larger phase groups. Though the number of active slots may not be an integral or whole (even) multiple of the number of coils per pole-phase group an even multiple of the number of poles may occur. In one type the number of active slots may be increased to an over-integral or reduced to an under-integral; in other words, we may obtain a

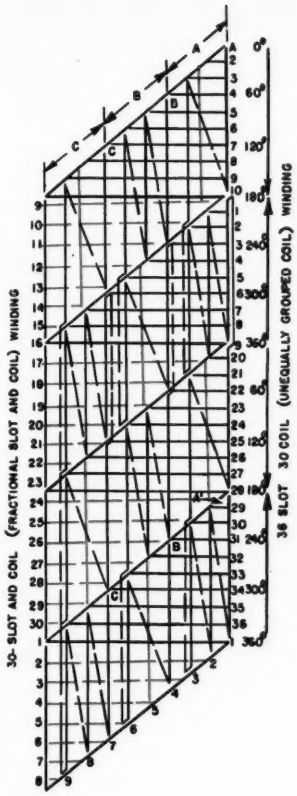


Fig. 1. (Left) Superimposed 4-pole, 3-phase, 36-slot, 30-coil and 30 slot and coil layouts with the former layout connected to show a fully developed, unequally grouped coil lap winding. (Red vertical lines indicate missing coils)

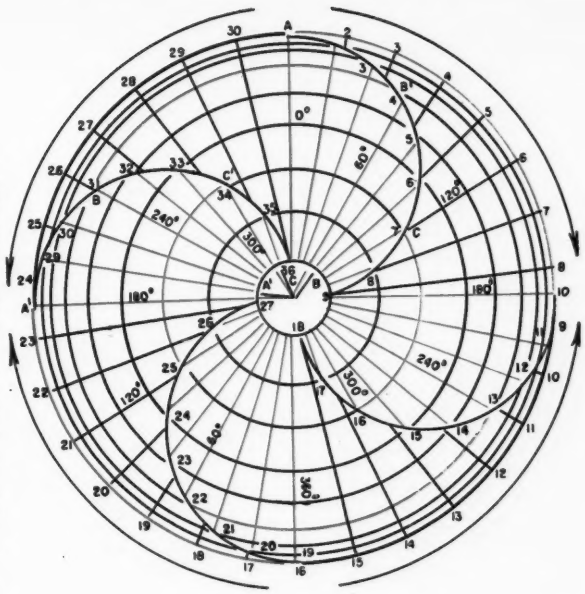


Fig. 1a. (Right) Showing 36 and 30 slot cores superimposed, and the nearest coincident-slot positions which are 1-7-13-19-25 and 31 in terms of the 36-slot core. This may represent both stator and rotor cores (Red arcs indicate missing coils)

fractional-coil winding from a fractional-slot core, or obtain the same from an integral-slot core by creating extra slots in the latter. Just as the underchorded winding diagram serves for reduced coil-throw windings, so the integral-slot winding diagram serves for reduced active slot or/and coil windings, and *vice-versa* in both cases. Figure 1 shows a 30 slot and coil layout and a 36-slot layout superimposed. Figure 2 shows a 27-slot and coil layout and a 36-slot 27-coil layout superimposed. These diagrams visualize the true "coincident" slot positions and show that the windings have the same electrically identical coil-side positions as the fractional slot and coil windings.

The essential practical information visualized in these diagrams is

(1) Number of slots and coils per phase belt, per pole, per pole-phase group and phase winding.

(2) The electrically identical and nearest equi-potential positions of every coil side (top and bottom), the exact or nearest (120 deg) phase-lead positions and their electrical degree angles and relations.

(3) Slot pitches and angular difference between slots of both integral and fractional-slot cores—showing all the coincident-slot positions and angular values.

(4) Correct positions and angles of extra, empty, killed, dead or partially dead slots.

(5) Correct order of coil grouping, showing which coil groups have a completely or partially "dropped" slot, which phase and pole it is in, its correct electrical angular degree relation with the next "dropped" slot, and whether the phase groups are balanced as regards voltages and magnetic pull.

(6) The *fully developed* winding connections as well as the *simplified* winding connections.

While coil connections, symmetry and balance are the principal requirements visualized in these diagrams, the following practical measures should be kept in mind for their attainment:

(a) Arrange the phase groups so that there is always an equal number of coils per phase winding. This applies in general to stator windings since rotors are usually star-connected and the difference made up externally.

(b) Arrange the phase groups so that there is the least possible coil difference between one pole and the next.

(c) Arrange the phase groups so that each phase has the same number of active slots and the larger phase groups distributed as evenly as possible around the periphery of the core.

(d) Retain all phase coils which have extra insulation, i. e., all those coils which lie at the start and finish of each pole phase group; in other words these coils lie at the phase-zone-boundary positions referred to above.

(e) Arrange the coil groups and their connections to get the best effect on magnetic pull and balance.

(f) Arrange the coil groupings so that balanced phases as regards current and voltage can be maintained for all load conditions.

As with chorded windings, one advantage of these forms of diagrams is the superimposed picture of both the integral slot and coil and the fractional slot and coil cores or/and windings such as stator and rotor. At a glance the correct (or most correct) positions of extra or partially or entirely empty slots are seen, i e. the positions and angular degree values at or nearest to the "coincident" slots or points where the slots of (say) two superimposed cores or/and

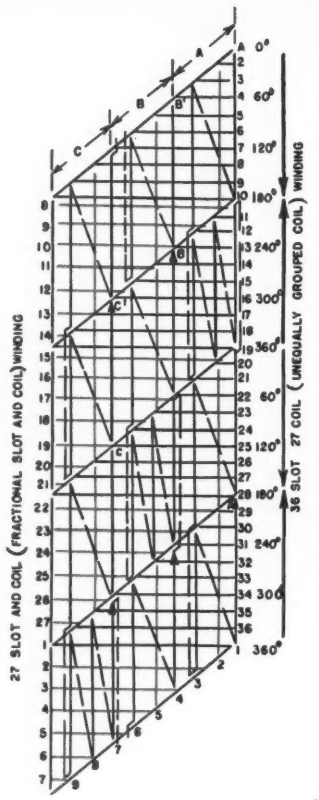


Fig. 2. (Left) Showing superimposed 4-pole, 3-phase, 36-slot, 27-coil and 27 slot and coil layouts with the former layout connected to show a fully developed, unequally grouped coil winding. (Red vertical lines indicate missing coils)

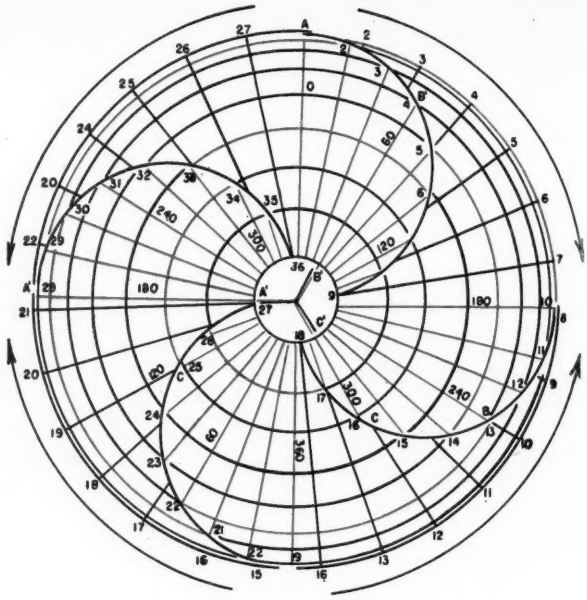


Fig. 2a. (Right) Showing 36 and 27 slot cores superimposed, and the nearest coincident-slot positions which are 1-5-9-13-17-21-25-29 and 33, in terms of the 36-slot core. This may represent both stator and rotor cores. (Red arcs indicate missing coils)

windings actually cancel or wipe-out one of the two slots overlapped.

Take a 36-slot core and fit it with full-pitch coils to give either (1) 33-active coils, (2) 30-active coils, or (3) 27-active coils, and assume that each of these three layouts is so connected as to produce a 2-layer 3-phase 4-pole lap winding, which is an *odd* phase *even* pole-pair winding. Extract the following from Figs. 1 and 2, and show other proof that the information is correct:

(a) Number of active coils per pole and per phase.
(b) Coincident-slot intervals, slot numbers and their electrical degree values.
(c) Nearest electrically identical coil-side positions for the integral-slot fractional-coil and the fractional-slot and coil layouts.
(d) Phase-lead positions and their electrical degree values.
(e) Positions of totally empty slots, if any.
(f) Order of coil grouping.
(g) Simplified winding table.
(h) Fully developed winding table.

For the 36-slot 30-coil (60-coil side) 3-phase 4-pole winding, Fig. 1 shows 7½ coils per magnetic pole or C/p = 30/4 = 7½, and 2½ coils per pole-phase group or C/p Ø = 30/4 × 3 = 2½.

Figure 1 shows the coincident-slot interval to be 5, or S/S-C = 36/36-30 = 5; hence, commencing in slot 1 and counting clockwise, a slot is "dropped" at the coincident 6-7 slots and so on for every five spacings around the periphery. Checking this, we get the following 30-active coil layout with slot numbering different to Fig. 1:

Poles	Phases			Phase groups			Coils per pole
	A	B	C	A	B	C	
1	1 x 2	3 4 5	6 y 7	2	3	2	7
2	8 9 10	11 x 12	13 14 15	3	2	3	8
3	16 y 17	18 19 20	21 x 22	2	3	2	7
4	23 24 25	26 y 27	28 29 30	3	2	3	8
				10	10	10	30 Total

Figures 1 and 1a show that no phase-lead is affected, that the 120 deg displacements are no different to the integral slot and coil winding, that the first slot interval and the intermediate positions (such as slots 2-8-14-20-26-32) are bodily pivited to avoid the phase-lead and phase boundary positions.

Figures 1 and 1a also show that no slot is completely empty—that all the so-called "empties" for a 2½ or 2¾ coils per pole-phase group possess at least one coil side; Table 1 is given to check the coincident-slot positions, the electrical angular degree values and the correct phase-zone boundary grouping positions. Based on the integral slot and coil layout these diagrams for unequally grouped coil windings prove that the electrically identical slots are the same as those of the fractional slot and coil winding; that is:

Poles	Phases			Poles	Phases		
	A	B	C		A	B	C
1	1 x 2	3 4 5	6 y 7	2	8 9 10	11 x 12	13 14 15
3	16 y 17	18 x 20	21 x 22	4	23 24 25	26 y 27	28 29 30

The order of coil grouping is also clearly visualized, that is:

2	3	2	3	2	3	2	3	2	3	2	3
A	B	C	A	B	C	A	B	C	A	B	C

The slot numbering may be changed to conform to the above tabulated top coil-side layout (differing from Figs. 1 and 1a which shows integral slot and coil numbering). For the simplified winding table we get

Phase A	1(0°)	8	16	23(180°)A′
Phase B	26(240°)	18	11	3(60°)B′
Phase C	6(120°)	13	21	28(300°)C′

Table I, Showing Coincident-Slot Intervals and Pole-Phase Groupings

33-slot and coil winding				30-slot and coil winding				27-slot and coil winding			
(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
1	0°	A		1	0°	A		1	0°	A	
2	21.81	A	3	2	24	A	3	2	26.66	A	3
3	43.63	A		3	48	A		3	53.33	A	
4	65.45	B		4	72	B		4	80.00	B	
5	87.27	B	3	5	96	B	2	5	106.66	B	2
6	109.09	B		6	120	C		6	133.33	C	
7	130.90	C		7	144	C	3	7	160.00	C	2
8	152.72	C	3	8	168	C		8	186.66	A	
9	174.54	C		9	192	A		9	213.33	A	2
10	196.36	A	2	10	216	A	2	10	240.00	B	
11	218.18	A		11	240	B		11	266.66	B	3
12	240.00	B		12	264	B	3	12	293.33	B	
13	261.81	B	3	13	288	B		13	320.00	C	
14	283.63	B		14	312	C		14	346.66	C	2
15	305.45	C		15	336	C	2	15	13.33	A	
16	327.27	C	3	16	360	A		16	40.00	A	2
17	349.09	C		17	24	A	3	17	66.66	B	
18	10.90	A		18	48	A		18	93.33	B	2
19	32.62	A	3	19	72	B		19	120.00	C	
20	54.44	A		20	96	B	2	20	146.66	C	3
21	76.26	B		21	120	C		21	173.33	C	
22	98.08	B	2	22	144	C	3	22	200.00	A	
23	120.00	C		23	168	C		23	226.66	A	2
24	141.71	C	3	24	192	A		24	253.33	B	
25	163.55	C		25	216	A	2	25	280.00	B	2
26	185.35	A		26	240	B		26	306.66	C	
27	207.17	A	3	27	264	B	3	27	333.33	C	2
28	228.98	A		28	288	B		1	360.00	A	
29	250.80	B		29	312	C					
30	272.62	B	3	30	336	C	2				
31	294.44	B		1	360	A					
32	316.26	C									
33	338.07	C	2								
1	360.00	A									

(a) Slot and coil numbers.
(b) Electrical angular spacing between slots.
(c) Phase.
(d) Number of active slots and coils per phase group.

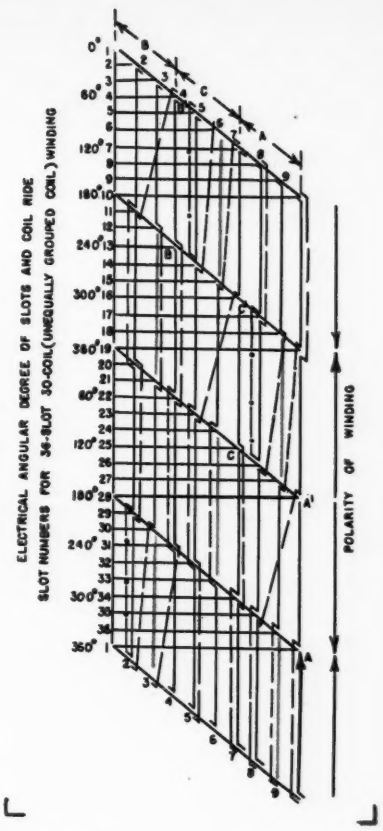

ELECTRICAL ANGULAR DEGREE OF SLOTS AND COIL RIDE
SLOT NUMBERS FOR 36-SLOT 30-COIL (UNEQUALLY GROUPED COIL) WINDING
POLARITY OF WINDING

Fig. 3. Diagram of a 4-pole, 3-phase, 2-layer, 36-slot, 30-coil, 2½ coils per pole per phase (unequally grouped coils) left-handed, top coil starting phase leads, retrogressive, 1 and 10 pitch wave winding. The polar diagram is the same as Fig. 1a when looked at from the back. (Red vertical lines indicate missing coils)

Though both methods are given, it is immaterial which slot numbering is used for extracting the fully developed winding table. Table II is extracted from Fig. 1:

Order of coil grouping is:

2	3	3	3	2	3	3	3	2	3	3	3
A	B	C	A	B	C	A	B	C	A	B	C

Simplified winding table is:

Phase A	1	(0°)	10	19	28	(180°) A′
Phase B	31	(240°)	22	13	4	(60°) B′
Phase C	7	(120°)	16	25	34	(300°) C′

And Table III is the fully developed winding table.

Table II. Data extracted from Fig. 1

	T	B	T B	T	B B	T	B	T	B	T T	B	T B	T	B B	T	B	T	B	T	
A	1	10	(dead)	3	12-21	12	20	11	10	10-19	28	(dead)	21	30-3	30	2	29	1	28	A′
	(0°)																		(180°)	
B	31	4	(dead)	33	6-33	24	32	23	31	22-13	22	(dead)	15	24-15	6	14	5	13	4	B′
	(240°)																		(60°)	
	7	16	(dead)	9	18-27	18	26	17	25	16-25	34	(dead)	27	36-9	36	8	35	7	34	C′
	(120°)																		(300°)	

Table III. Fully-developed winding table

	T	B	T B	T	B B	T	B	T	B	T T	B	T	B	T	B B	T	B	T	B	T	
A	1	10	(dead)	3	12-21	12	20	11	19	10-19	28	20	29	21	30-3	30	2	29	1	28	A′
	(0°)																			(180°)	
B	31	3	32	4	33	6-33	24	32	23	31	22-13	22	(dead)	15	24-15	6	14	5	13	4	B′
	(240°)																			(60°)	
C	7	16	8	17	9	18-27	18	26	17	25	16-25	34	(dead)	27	36-9	36	8	35	7	34	C′
	(120°)																			(300°)	

Now let us fill the three following partly empty slots 8-17, 20-29-32-5 by inserting three coils and renumbering the new winding, thus making a 2-layer 36-slot 33-coil 66-coil side 3-phase 4-pole winding with 8¼ coils per pole or C/p = 8¼, and 2¾ coils per pole-phase group or C/pØ = 33/4 × 3 = 2¾.

The coincident-slot spacing in terms of active coils is 12, and the 33-active coil layout in this case is:

Poles	Phases			Phase groups			Coils per pole
	A	B	C	A	B	C	
1	1 x 2	3 4 5	6 7 8	2	3	3	8
2	9 10 11	12 x 13	14 15 16	3	2	3	8
3	17 18 19	20 21 22	23 x 24	3	3	2	8
4	25 26 27	28 29 30	31 32 33	3	3	3	9
				11	11	11	

In place of filling three of the partly empty slots in the 30-active coil winding, let us take away three active coils, thus making a 2-layer 36-slot 27-active coil (54-coil side) 3-phase 4-pole winding with 6¾ coils per pole or C/p = 27/4 = 6¾, and 2½ coils per pole-phase group or C/p Ø = 27/4 × 3 = 2¼.

Figs. 2 and 2a show the coincident-slot spacing to be 4, or S/S-C = 36/36-27 = 4, and the winding layout to be:

Poles	Phases			Phase groups			Coils per pole
	A	B	C	A	B	C	
1	1 x 2	3 y 4	5 y 6	2	2	2	6
2	7 8 9	10 x 11	12 y 13	3	2	2	7
3	14 z 15	16 17 18	19 x 20	2	3	2	6
4	21 y 22	23 z 24	25 26 27	2	2	3	7
				9	9	9	27 Total

Table IV. Fully-developed winding from Fig. 2

	T	B	T B	T	B	B	T	B	T	B	T	T	B	T B	T	B	B	T	B T	B	T	
A	1 (0°)	10	(dead)	3	12	21	12	20	11	19	10	19	28	(dead)	21	30	3	30	(dead)	1	29 (180°)	A′
B	13 (240°)	22	(dead)	15	24	33	25	32	23	31	22	31	4	(dead)	33	6	15	6	(dead)	13	4 (60°)	B′
C	25 (120°)	34	(dead)	27	36	9	36	8	35	7	34	7	16	(dead)	9	18	27	36	(dead)	25	16 (300°)	C′

Table V. Fully-developed winding from Fig. 3

	T	B	T	B	T B	T B	T	B	T	B	B	T	B	T	B	T	B	T	B	T	
A	1 (0°)	10	19	28	(dead)	(dead)	35	8	17	26	17	8	35	26	18	9	36	27	19	10	1	28 (180°)	A′
B	13 (240°)	22	31	4	(dead)	(dead)	11	20	29	2	29	20	11	2	30	21	12	3	31	22	13	4 (60°)	B′
C	25 (120°)	34	7	16	(dead)	(dead)	23	32	5	14	5	32	23	14	6	33	24	15	7	34	25	16 (300°)	C′

Order of coil grouping from Fig. 2 is:

2	2	2	3	2	2	2	3	2	2	2	3
A	B	C	A	B	C	A	B	C	A	B	C

The simplified winding diagram in terms of 36 slots 27 coils, is:

Phase A	1	(0°)	7	14	21	(180°) A′
Phase B	10	(240°)	17	24	3	(60°) B′
Phase C	19	(120°)	26	7	12	(300°) C′

Due to seeking the 120 deg phase-lead positions which are 1-13-25, the fully developed winding from Fig. 2 is shown in Table IV.

Now take a 36-slot 30-coil (60 coil side) left-handed retro-gressive 3-phase 4-pole *wave* winding (Fig. 3) which shows the following pole and phase coil-groupings:

Poles	Phases			Phase groups			Coils per pole
	A	B	C	A	B	C	
4	25 y 26	27 28 29	30 x 7	2	3	2	7
3	17 18 19	20 x 21	22 23 24	3	2	3	**8**
2	10 x 11	12 13 14	15 y 16	2	3	2	7
1	2 3 4	5 y 6	7 8 9	3	2	3	8
				10	10	10	30—Total

The order of coil grouping, visualized in Fig. 3, is:

3	2	3	2	3	2	3	2	3	2	3	2
A	B	C	A	B	C	A	B	C	A	B	C

A mere mention of this order of coil grouping is of itself misleading and of little use to the average engineer, yet it is all that writers give.

Referring to the *wave* winding Rule (Part II) the same winding procedure is carried out and the following *fully developed* winding table (Table V) is extracted from Fig. 3.

(*Continued on Page* 134)

Midget Transmission Line Shows Use of Capacitors

ELECTRITY FLOWING through a midget power line recently demonstrated that existing transmission systems can be stepped up to carry 65 per cent more power by adding thousands of small capacitor units. R. D. Evans, consulting transmission engineer at the Westinghouse Electric & Mfg. Co.'s East Pittsburgh Works, conducted the laboratory experiment to prove a theory he developed.

By using 7200 of the small capacitors together with the necessary generating equipment, a 250-mile-long power line with a capacity of 175,000 kw can be stepped up to carry 290,000 kw. This 115,000 kw increase would be sufficient to supply all the electrical needs of a city of 350,000 population. Evans demonstrated his theory by means of a miniature power system consisting of a motor-driven generator, transformers, reactors, resistors and capacitors; meters were used to check the results.

Use of capacitors to increase a power line's effectiveness not only is efficient but also is the most economical way, according to Evans. Heretofore, the most common method of boosting a power line's capacity was through the addition of more transmission wires; however, the cost of an additional power line plus auxiliary equipment to step up a 250-mile-long line's capacity 65 per cent would be about $4,500,000. With 7200 capacitors necessary to step up a 250-mile-long line's capacity 65 per cent the cost would be about $1,200,000. This, of course, does not include a generator which would be necessary in either case.

Conserves Vital Metals

Installation of capacitors to increase capacity instead of extra power lines also conserves vital metals, the Westinghouse engineer points out. The 7200 capacitors can be built out of nine tons of copper and brass, 175 tons of steel and a few tons of aluminum; extra power lines and electrical equipment would require 2900 tons of copper and 7600 tons of steel. According to the Westinghouse engineer, the new plan for using capacitors to step up the capacity of a power line calls for locating the devices in a steel structure erected underneath the power line. Of course, the three wires of the transmission system would run through the capacitors. A few years ago the new idea would not have been feasible with the protective equipment then in existence. However, a protective system has been developed in which switches automatically cut off the bank of capacitors from a circuit when a short circuit occurs—then restores service when the trouble clears.

Capacitors for power circuit purposes were first used about two decades ago but for many years their price limited their use. Today, as the result of research work by manufacturers of electrical equipment, capacitors cost less than a third of their former price.

Circular Saw Cuts Copper Well

COPPER is a difficult material to machine or saw by hand. To reduce width of a copper bus bar that is several feet in length, is, as a rule, a tedious job.

This, however, can be quickly and neatly done by a carpenter's circular rip saw. A saw of about 8 in. dia with teeth about an inch apart and operating at the usual peripheral speed, about 5000 ft per min does very well. The teeth should project through the cut only a short distance, is a rule that is also good when ripping wood.

It is advisable to wear goggles to protect the eyes from particles of copper.

AMERICAN ENGINEERING CO.

Adds 400-kw Unit To Help Carry War Load

The recent installation of a new 400-kw engine-driven generator gives the power plant of The American Engineering Co. at Philadelphia, Pa., ample generating capacity to meet the increased demands made by the war load. Over 30 years old, this plant has never failed to supply all the power needed in the manufacture of Taylor stokers. The plant has five engine-driven generating units all of which operate non-condensing, the exhaust steam being used for heating

THE AMERICAN ENGINEERING CO. in Philadelphia has for many years operated its own power plant in which all the electrical energy used in the factory is generated. At the present time this plant is over 30 yr old.

Until last year when the new engine-generating unit described in this article was placed in operation, all power was produced by four old engines. Two of these were 13 by 23 by 16 in. tandem compound, Harrisburg engines driving 165 kw, 120/240-v Triumph Electric Co. d-c generators; one was a 13 by 22 by 18 in. Fitchburg engine driving a 150-kw General Electric Co. d-c generator, while the fourth was a small 10 by 12 in. simple Harrisburg engine driving an old Electric Dynamic Co. generator.

The latter is a 60-kw unit. It was bought in 1899 and was first installed in the shop and was moved to the power plant when it was built in 1911.

The two Harrisburgs were also installed in the plant at that time and then, in 1913, when additional generating capacity was needed, the Fitchburg engine was put in. S. O. Large, the present chief engineer, came to the plant in 1911 and has been there ever since.

This, briefly, is the history of this old but well-operated plant. Through the years it has given excellent service, and has met all the power requirements of the large stoker factory, where the Taylor stoker is made. All engines operate non-condensing, the exhaust steam being used for heating buildings and process work.

The plant went through the first world war without expansion. This often imposed considerable strain both on the equipment as well as the operating force but no serious shutdowns were necessary. At times it was necessary to take the cap off the main bearing and adjust it during a noon hour and put in new cylinder liners but, in general, they managed.

With the onset of this present war, however, the situation was different. The plant was older and in the years between, the factory and consequently, the load had grown. There was very little reserve capacity and steps were taken at once to expand the capacity by the addition of a new unit. The new Skinner Unaflow engine was purchased and it went into operation in July of 1942—just about a year ago. It was fortunate that this move was taken in time because if it had been delayed another two months the engine would have been impossible to get.

This new unit is a Skinner Engine Co., Universal Unaflow en-

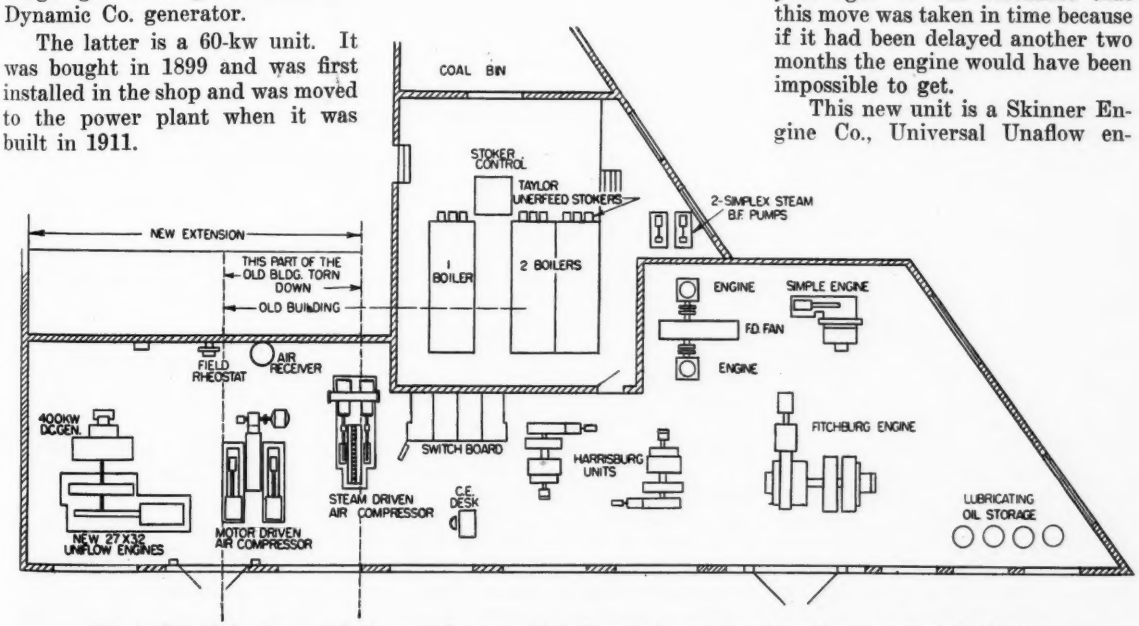


Fig. 1. Plan of the American Engineering Co. power plant showing the new extension with respect to the old building

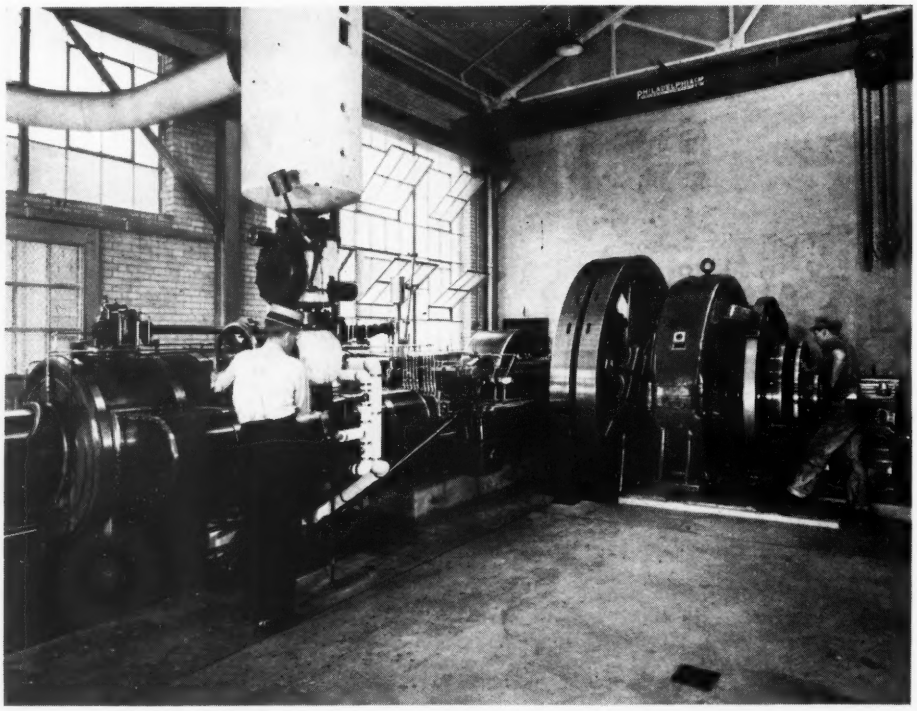


Fig. 2. A general view of the new engine installed in the extension to the plant

gine, 27 by 32 in. operating at about 150 lb steam pressure and directly connected to a 400-kw, 125/150-v direct-current Crocker-Wheeler generator. It operates at 150 rpm.

With this new engine, the plant will have no trouble in carrying any load that may be imposed upon it for some time to come. The new unit itself is easily capable of carrying the normal plant load, which leaves the four old engines available as reserve capacity.

Method of Building Extension

The installation of the new generating unit necessitated a number of changes in the building structure. The general arrangement of the equipment in the plant as it is today is shown in Fig. 1. Before the new engine was installed, however, the plant included only that portion to the right of the dotted line. As shown by the small sketch in Fig. 5 which represents a side elevation, the old building, including the boiler house, had a flat roof. When the extension for housing the new engine was built, it was made with a sloping roof, slightly higher than the old portion of the building. In this way the new portion of the building could be built over the old portion without interfering with the operation of the equipment in that portion of the old building which was subsequently torn down. The sloping roof on the new portion also permitted the use of windows in the upper part of the room.

As may be seen in the accompanying photographs of the new engine, the interior of the new portion of the engine room is finished with the white pressed brick. All exposed steel work is painted with aluminum paint. A 5-ton overhead crane is installed to handle the engine and other equipment.

When the engine was installed, a new switchboard was also added. This is a modern steel enclosed, 5-panel board with Weston flush type meters and ITE air circuit breakers. This board serves not only the new generating unit but also the four old machines.

The Boiler Room

No changes were necessary in the boiler room but a brief description may be of interest. As shown in the drawing the boiler room is centrally located with respect to the engine room but is entirely separate from it. It contains three Babcock & Wilcox water tube boilers. Two of these units were installed in 1911 while the third was installed in 1913. As might be expected in the plant where Taylor stokers are produced, all three boilers are fired by Taylor underfeed stokers. The boilers were built for a working steam pressure of 160 lb and they are carrying that pressure at the present time.

The arrangement is very simple. Coal is stored in a large bin opposite the boilers, the floor of which is on a level with the boiler operating floor. As a consequence no coal handling machinery is installed. The coal is wheeled from the bin in wheelbarrows and dumped into the stokers' hoppers, the tops of which are just flush with the operating floor. A scale is placed opposite the coal-bin door and as each wheelbarrow load is wheeled out it

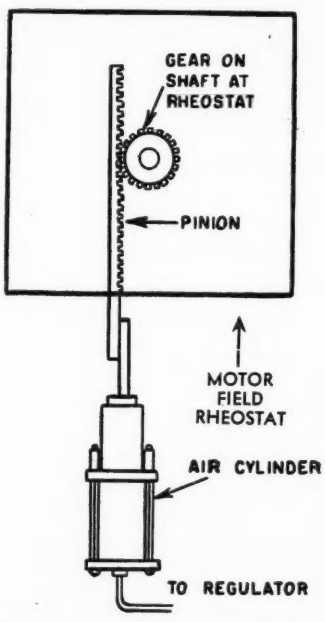


Fig. 3. Rheostat control arrangement for the electrically-driven air compressor

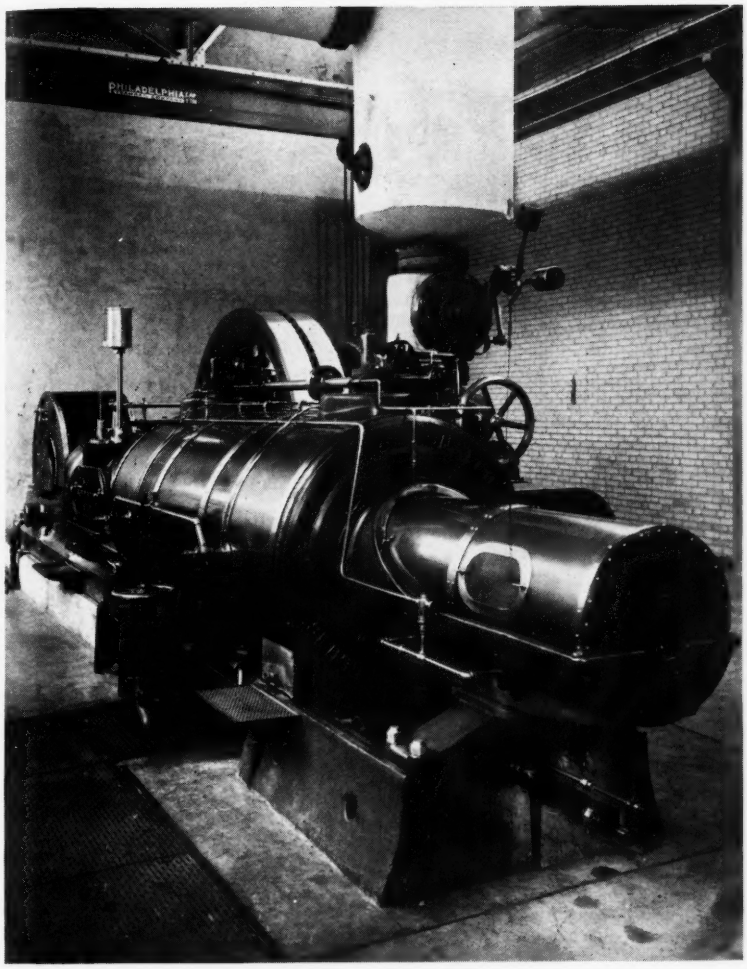


Fig. 4. Another view of the new engine

is weighed before being delivered to the stoker hoppers.

The boilers operate with natural draft above the level bed but a forced draft fan is provided to supply air below the stoker. This forced draft fan, as may be noted, is located in the engine room and is driven by either of two small vertical steam engines. One of these engines is sufficient to drive the fan, the other being provided merely as a spare. Shaft couplings are provided so that each engine may be connected to the fan as occasion demands.

Feedwater used by the boilers is Philadelphia city water. This is heated by exhaust steam from the engines and auxiliaries in a Warren Webster open type feedwater heater and is metered by a Yarnall-Waring V-notch meter with a Lea recorder. The feedwater heater is vented to the atmosphere through a Cochrane atmospheric relief valve. The feedwater is treated chemically to prevent scale formation and to reduce corrosion. The two boiler feed pumps are old Simplex units, 9 by 6 by 12 in. These take suction from the feedwater heater which is located directly above. The chemical feed is rather interesting. This chemical is introduced into the feed line by a small piston type pump which is mounted on the boiler feed pump and receives its motion from the feed pump piston. Thus the rate of chemical feed is always directly proportional to the feedwater flow.

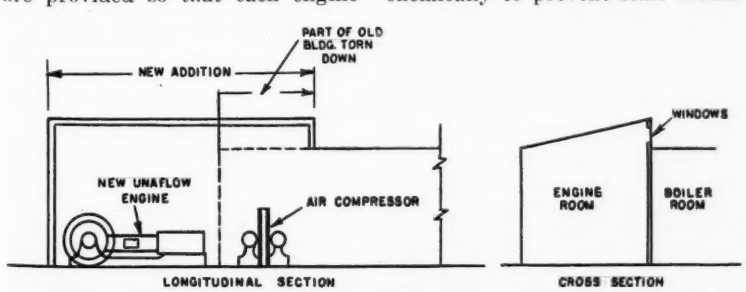


Fig. 5. Diagram showing the method of building the new addition over the existing building structure

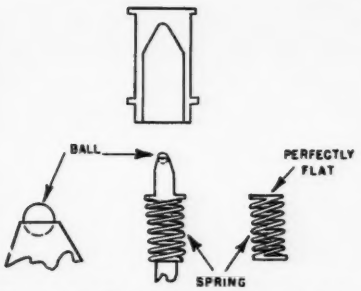


Fig. 6. Details of ball bearing support in air compressor unloading valves

Besides the five engine-driven generators and the forced draft fan, the engine room contains two cross-compound air compressors. One of these is steam driven, the other by a direct current motor.

No description of this plant would be complete without directing attention to several small but important items which Mr. Large, the chief engineer, has brought about. One, in particular, concerns the operation of the electrically-driven air compressor. The speed of this machine is controlled by an arrangement which varies the position of the field rheostat in accordance with the air pressure on the output side of the compressor by means of a Cash regulator. A sketch of the arrangement is shown in Fig. 3. The operating shaft of the field rheostat of the driving motor is driven through a rack and pinion by an air cylinder which receives its air from the Cash regulator. The arrangement is simple but it works perfectly. A pin in the pinion can be removed to convert the system into manual operation.

Another useful and practical arrangement which Mr. Large devised is the ball bearing support in the unloading valves on the air compressors. The use of a ball bearing in this manner is approved practice in safety valve construction and it improved the operation of these unloading valves considerably. In closing we acknowledge the assistance and cooperation of the officials of the American Engineering Co. in presenting this article.

Conversion From Oil Firing to Coal Firing[1]

Detailed analysis of furnace designs in conversions showing relation between amount of water-cooled furnace surface and furnace temperature based on heat available in Btu per sq ft of water-cooled surface per hour. Data are given on steam capacities in conversions, relations of furnace and ash-softening temperatures to heat available and reduction of furnace temperature by recirculation of flue gas. Weight and cost of materials required in conversions are discussed. Direct-fired circulating systems are illustrated.

By R. M. Hardgrove, ***The Babcock & Wilcox Co.***

FOR SOME YEARS many people have recognized the advisability of installing boiler units so designed that they could burn oil or pulverized coal, whichever was the cheaper fuel or the most readily available; or, if the burning equipment for only one fuel was installed initially, to design the furnace so that it would be suitable for conversion to the other fuel with a minimum of changes. The advantages of this policy are clearly apparent at present.

Units Suitable for Conversion

Completely water-cooled furnace units, such as the integral furnace boiler and similar designs, have met these requirements very well and many of these units have been converted to pulverized-coal firing with a minimum of furnace changes and little or no reduction in capacity.

Slag tap pulverized-coal fired furnaces of the larger sizes are equally suitable for oil or pulverized-coal firing and present no problem at this time.

Pulverized-coal fired units of medium and small size are not suited to liquid ash removal, and to remove the ash in a dry form, sufficient water-cooled surface must be installed in the furnace to reduce the furnace temperature below the softening temperature of the coal ash.

Water cooling in oil-fired furnaces is justified largely by the reduction in maintenance obtained. Many furnaces designed for firing oil only have some water-cooled surface, but usually it is not adequate for firing with pulverized coal at the same output. On the other hand, any furnace suitable for firing pulverized coal can be fired with oil at the same maximum output as with coal.

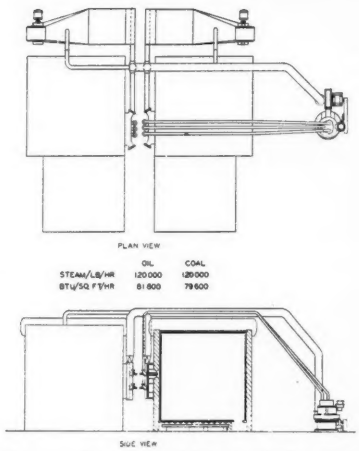


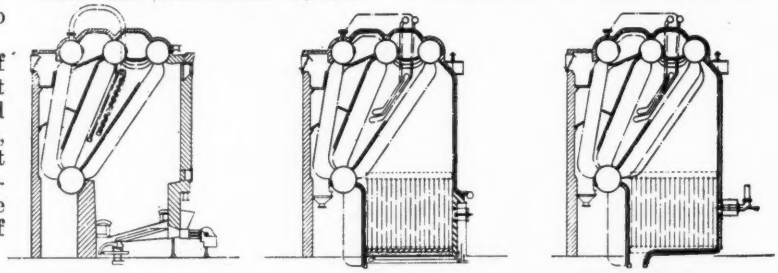
Fig. 1. Two integral-furnace boiler units converted from oil to pulverized-coal firing

Arrangement of the units in the building did not provide an ideal location for the pulverizers, due presumably to the prospects of conversion being considered remote at the time the initial installation was made. But fortunately the boiler units were so designed that they were suitable for pulverized-coal firing. This installation illustrates clearly the adaptability of pulverized-coal firing to difficult and unconventional layouts.

Heat Available is Governing Factor

The dimensions of a furnace are governed somewhat by the burner clearances required, but the volume of the furnace alone has little effect on furnace temperature and the commonly used unit—liberation in Btu per cu ft per hour—is actually only a measure of the time the fuel and air are in the furnace.

The best unit for obtaining a relation between the amount of water cooling and furnace temperature is the **heat available in Btu per sq ft of water-cooled surface per hour.** The heat available is the heat in the fuel burned, plus the heat in the preheated air, less the latent heat of the water vapor in the products of combustion. In other words, it is



STOKER		OIL	PULV. COAL
40,000	STEAM LB/HR	84,000	55,000
235,000	BTU/SQ FT/HR	138,000	66,300

Fig. 2. Conversion of Stirling boiler first from stoker to oil firing, with proposed conversion from oil to pulverized coal

In the above table the heat available with stoker firing is not comparable to the heat available with pulverized-coal firing, due to the large proportion of the heat developed in the fuel bed. The relatively low steam capacity with stoker firing was limited by the restricted fuel bed area available in the setting.

Some water cooling was added when converting from stoker to oil firing, resulting in a large increase in capacity, above that obtained with stoker firing. When converting to pulverized-coal firing, essentially all the water-cooled surface possible without enlarging the furnace will have to be installed. Even then it will be necessary to reduce the capacity appreciably to prevent slagging.

[1]Extracted and adapted from a paper entitled Conversion of Boiler and Metallurgical Furnaces From Oil to Coal Firing presented at Joint Meeting of Fuels and Steam Power Divisions, Metropolitan Section, ASME, New York, March 22, 1943.

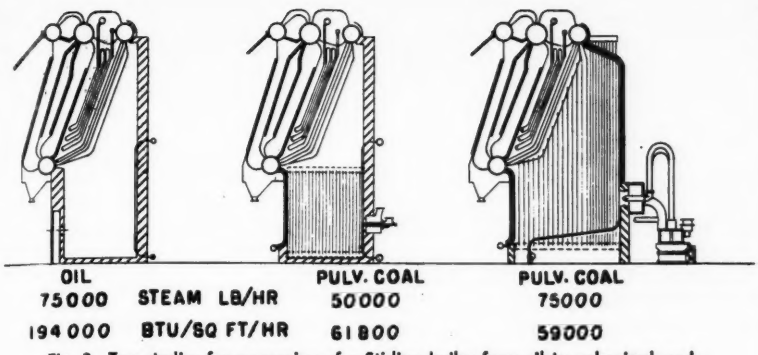


Fig. 3. Two studies for conversion of a Stirling boiler from oil to pulverized coal

The view at the center was the first study made for pulverized-coal firing and shows the addition of water-cooled side walls and rear wall in addition to the existing front wall, but this amount of surface was only enough for 50,000 lb steam per hour and the reduction in capacity was unacceptable.

The view at the right shows the second design in which the front wall was moved out 5 ft and the furnace completely water cooled, which provides enough water-cooled surface to operate the unit at the same capacity as with oil firing.

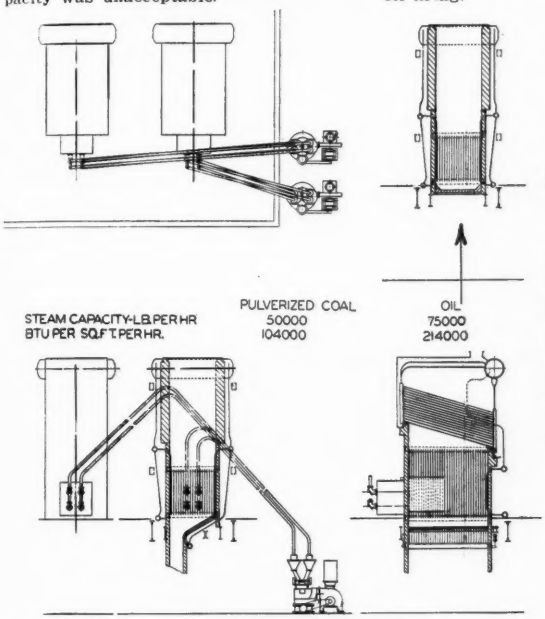


Fig. 4. Conversion of a B&W boiler from oil to pulverized coal

These units originally had the sides and rear wall water cooled for oil firing and the water-cooled floor was added on conversion to pulverized-coal firing. Even with the additional water cooling and using a relatively high fusing ash coal, a reduction in capacity is necessary to avoid slagging difficulties.

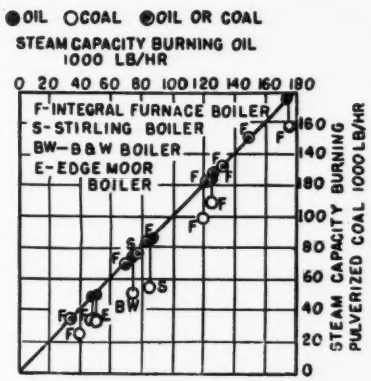

●OIL ○COAL ◉OIL OR COAL
STEAM CAPACITY BURNING OIL
1000 LB/HR
0 20 40 60 80 100 120 140 160 180
F-INTEGRAL FURNACE BOILER
S-STIRLING BOILER
BW-B&W BOILER
E-EDGE MOOR BOILER
STEAM CAPACITY BURNING PULVERIZED COAL 1000 LB/HR
0 20 40 60 80 100 120 140 160 180

Fig. 5. Reduction in capacity necessary in a group of conversions

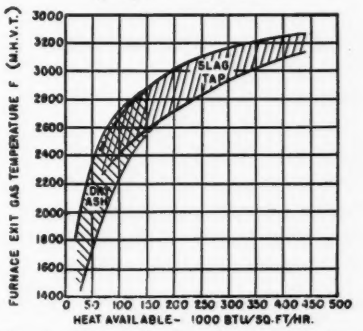


Fig. 6. Curves showing furnace exit temperature on a number of pulverized-coal installations plotted against heat available

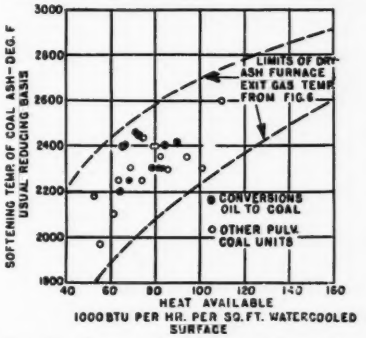


Fig. 7. Curves of softening temperature of ash plotted against heat available for a number of actual conversions

the useful heat available for producing radiant heat.

Capacities Obtained in Conversions

Figure 1 shows two integral furnace boiler units which have been converted from oil to pulverized coal firing by the installation of pulverizers and burners, with no changes to the furnace and no reduction in the capacity of the units. The capacity for each arrangement is:

	Oil	Pulverized Coal
Steam Capacity lb per hour	120,000	120,000
Heat Available Btu per sq ft water-cooled surface per hour	81,800	79,600

Figure 2 shows the conversion of a Stirling boiler installation from underfeed-stoker firing to oil firing in 1931 and a recently proposed conversion from oil to pulverized-coal firing. The capacity for each arrangement is shown on the diagram.

Figure 3 shows the conversion of another Stirling boiler.

Figure 4 shows a B&W boiler conversion. The capacity for each arrangement is shown on the drawing.

As is seen from Figs. 2, 3 and 4, a reduction in capacity is sometimes necessary when converting from oil to coal firing unless extensive furnace changes are made or unless high fusion ash coal, if economically available, is burned. Figure 5 shows the reduction in capacity necessary on a group of conversions. The integral furnace boilers comprising 11 of the 15 plants shown were the first to be converted, as they required few changes to obtain little or no reduction in capacity. Units requiring more extensive changes like those shown in Figs. 2, 3, and 4 will no doubt form a larger percentage of conversions from now on, although involving greater cost.

Relations Between Furnace and Ash-Softening Temperatures

Figure 6 shows the furnace exit temperature on a large number of actual pulverized-coal fired installations plotted against heat available. The shaded bands represent the range of the test points and, while the band is quite wide, it represents variations in type of

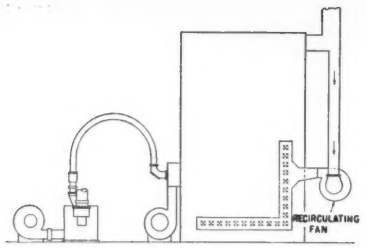


Fig. 8. Diagram showing how flue gases are recirculated to furnace to reduce furnace temperatures below ash-softening temperature

Table showing effects of recirculating flue gas

	Oil Refractory Floor	Pulverized Coal No Recirculation of Flue Gases Water-Cooled Floor		Pulverized Coal 27% Flue Gases Recirculated
Column	1	2	3	4
Steam Capacity lb/hour	70,000	70,000	52,000	70,000
Heat Available Btu/sq ft/hour	115,000	101,000	75,000	101,000
Excess Air—per cent	20	20	20	20 + 27% flue gases
Furnace Temperature-F	2225	2550	2445	2180
Fan Power, HP	32.7	35.3	21.7*	58.6
Efficiency	79	74.3	77.2*	74.1

*Reduced fan power and increased efficiency are due to lesser steam output.

load, excess air, types of surface, and particularly a large difference in degree of cleanliness of the surface. The central portion of the band is, however, a starting point for estimating the amount of water cooling required for coal of a known ash softening temperature.

In Figure 7 the softening temperature of the coal ash is plotted against heat available for a number of actual conversions. The points plotted are the softening temperatures determined on the usual reducing basis. The softening temperatures determined on an oxidizing basis[2] are considerably higher on ash having a high iron content and represent the oxidizing conditions of the actual furnace more accurately, but are seldom available at the time studies are made. When such information is obtainable on the coals available, the design can be established more accurately. The limits of the dry ash furnace temperature band from Fig. 6 are added for comparison.

For operation with dry ash removal, it is desirable for the majority of these conversion jobs to install ample water-cooled surface in the furnace, to insure operation at the desired capacity when operating with coals of lower ash softening temperature.

Plan Conversions Properly

The only safe procedure is to assume that oil as a fuel may never again be as plentiful or as favorable in price as it was before the war and to plan all conversions as permanent installations. There may be cases where shortage of materials will not permit making the type of installation at this time that should be made, but the design should be so planned that the additional equipment required to give a trouble-free job can be added as soon as material is available.

Recirculation of Flue Gas

A well-known method of reducing furnace temperatures below those giving trouble from slag or other difficulties is by recirculating some of the flue gases and bringing them into the furnace as shown diagrammatically in Fig. 8.

This same principle is applicable to keeping the temperature of boiler furnaces below the softening temperature of the ash. In fact, the same effect has been obtained extensively for a long time by using a large quantity of excess air, as before water-cooled furnaces were used it was common practice

As shown in Column 2, changing from oil to coal firing, even with the addition of a water-cooled floor, would give a furnace temperature of 2550 degrees, which may be too high for the coal being used. Reducing the capacity to 52,000 as in Column 3 would give a furnace temperature still higher than is desired, but within possible operating range with high fusing ash coal. By recirculating 27 per cent of the flue gases, Column 4, the temperature can be reduced to 2180 F at the same output as when firing oil, and thus insure dry ash removal and elimination of slagging troubles in the furnace. The additional fan power required for the operation with recirculation of flue gases is 23.3 hp.

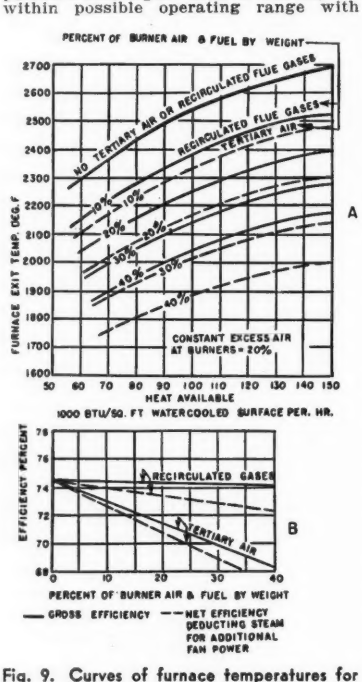


Fig. 9. Curves of furnace temperatures for various percentages of tertiary air and recirculated flue gas plotted against heat available. A—Top curve shows temperatures with 20 per cent excess air, no tertiary air or recirculated flue gas. B—Efficiencies for range of tertiary air and recirculated flue gas

to run with excess air up to 60 per cent. This additional excess air is more effective in cooling the furnace walls and floor if it is introduced through well-located ports as tertiary air, rather than being merely added through the burners with the required air for combustion.

An example of the application of the recirculation of flue gases to the water-cooled furnace of a boiler unit is given in the table.

In Fig. 9 the furnace temperatures for various percentages of tertiary air and recirculated flue gas are plotted against the heat available, based on assumed conditions less favorable than the average. The top curve in Fig. 9A represents the furnace temperature with 20 per cent excess air at the burners and no tertiary air or recirculation of flue gases, and the lower dotted lines the temperatures with tertiary air added. The solid lines represent the temperatures with 20 per cent excess air at the burners and various percentags of recirculated flue gases.

From this plot it is seen that whereas a furnace temperature of 2400 F would require a heat avail-

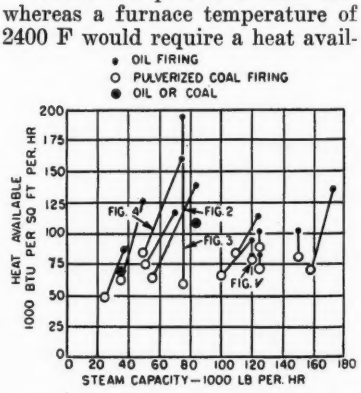
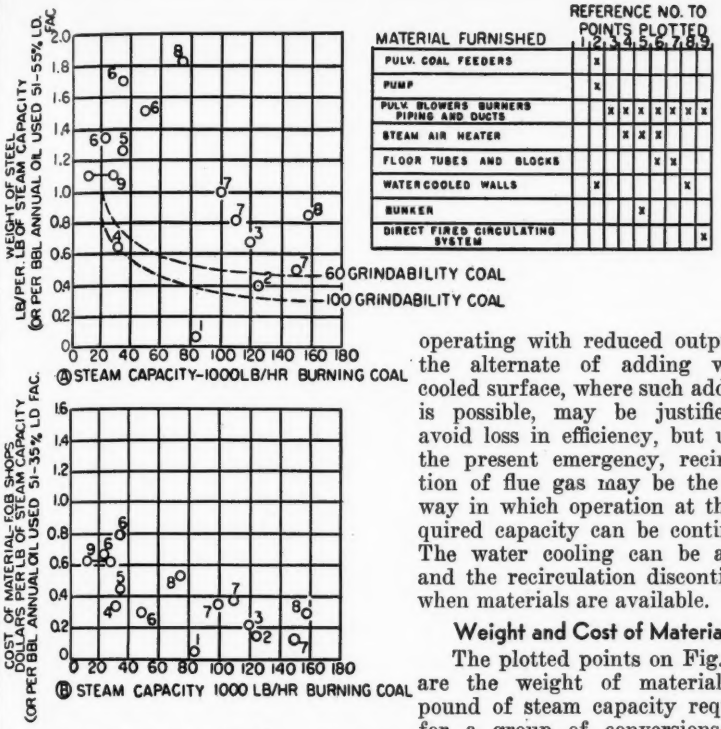


Fig. 10. Curves of reduction in heat available required by conversion

[2]Significance of Coal-Ash Fusing Temperature in the Light of Recent Furnace Studies, by E. G. Bailey and F. G. Ely, ASME Trans., Vol. 63—1941.



MATERIAL FURNISHED	REFERENCE NO. TO POINTS PLOTTED 1	2	3	4	5	6	7	8	9
PULV. COAL FEEDERS	X								
PUMP	X								
PULV. BLOWERS BURNERS PIPING AND DUCTS		X	X	X	X	X	X	X	X
STEAM AIR HEATER				X	X	X			
FLOOR TUBES AND BLOCKS						X	X		
WATER COOLED WALLS	X							X	
BUNKER					X				
DIRECT FIRED CIRCULATING SYSTEM									X

Fig. 11. Material required for a group of conversions. A—Weight of material per pound of steam capacity not including coal-handling equipment. B—Cost of equipment per pound of steam capacity

able of 75,000 Btu per sq ft of water-cooled surface per hour with 20 per cent excess air and no recirculation of flue gases, this same temperature can be obtained with a heat available of 150,000 Btu per sq ft of water-cooled surface per hour if tertiary air amounting to 15 per cent of the burner air plus fuel is used, or if 20 per cent flue gases are recirculated in addition to the 20 per cent excess air through the burners.

In Fig. 9B the efficiencies for the range of tertiary air and recirculated flue gas are plotted. The efficiencies with flue gas circulation remain fairly constant, as the reduced radiant heat in the furnace and the reduced temperature entering the convection surface is almost compensated for by the higher mass flow over the convection surface. The efficiency drops when tertiary air is used, as the weight of stock gases increases.

The draft loss will be higher and additional weights of air and gas must be handled by the fans. The steam required to develop this additional fan power has been estimated and deducted from the gross efficiency curves to obtain the net efficiency curves shown. Under ordinary conditions, the cost of operating with reduced output or the alternate of adding water-cooled surface, where such addition is possible, may be justified to avoid loss in efficiency, but under the present emergency, recirculation of flue gas may be the only way in which operation at the required capacity can be continued. The water cooling can be added and the recirculation discontinued when materials are available.

Weight and Cost of Materials

The plotted points on Fig. 11A are the weight of material per pound of steam capacity required for a group of conversions, but includes no coal handling equipment. The weight of material required for water walls varies widely with the specific installation and increases the total weight. The coal handling equipment may require as much or more additional weight of steel than the pulverizers and burners and will vary widely on different installations. Figure 11B shows the cost of equipment per pound of steam capacity.

Oil-fired boilers in the group being considered will generally use one barrel of oil per year for each pound of hourly steam capacity if operated at 51-55 per cent annual load factor. The cost and weights on Figs. 11A and B can, therefore, be considered as being equal to the weight and cost per barrel of annual oil consumption if the units are operated at 51-55 per cent annual load factor, or the barrels of oil saved per boiler per year is equal to the steam capacity in pounds per hour. Adding the cost of erection and coal handling equipment, the total cost may be more than double the values shown, but this is no reason for not converting.

Many small boiler plants may be converted that have no available space for direct-fired pulverizers or coal bunkers in the present building by methods shown in Fig. 13.

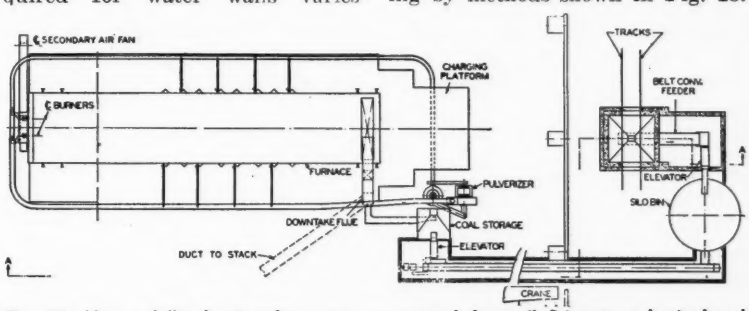


Fig. 12. How a billet heating furnace was converted from oil firing to pulverized-coal firing with a direct-fired circulating system

Average fuel consumption was about 2400 gal of oil per day, burned through two oil burners at the end of the furnace, each burner having a maximum capacity of 60 gal per hour. Sixteen gas burners were arranged along the sides, having a total maximum capacity of 5870 cu ft of natural gas per hour.

Because of space limitations, it was impossible to locate a direct-fired pulverizer near the large burners, so that the pulverizer was installed at the other end of the furnace and the direct-fired circulating system arranged to supply the two main burners at the end and four small burners on each side.

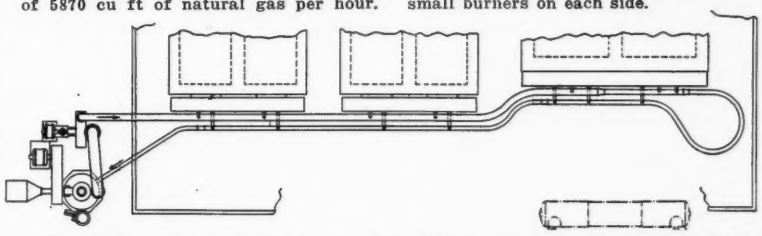


Fig. 13. How a group of 4 Stirling and 2 B&W boilers was converted to pulverized coal

The total steam required is about 80,000 lb per hr and the coal is supplied by one pulverizer located outside the building through a circulating system arranged adjacent to the furnace. For this condition a very compact arrangement consists of a silo for raw coal storage with the pulverizer located underneath.

A track hopper and elevator constitute the only conveying equipment required and no building is needed for the pulverizer. The material for the pulverizer piping and burners is 1.15 lb and costs $0.63 per pound of steam capacity, which is less than a direct-fired pulverizer installation and is very reasonable considering the small size of the units, namely 80,000 lb per hour from six units.

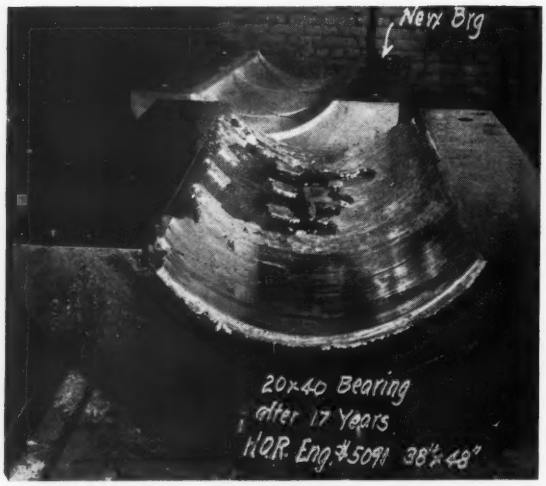


Fig 1. Condition of the old bearing after it had been removed from the engine

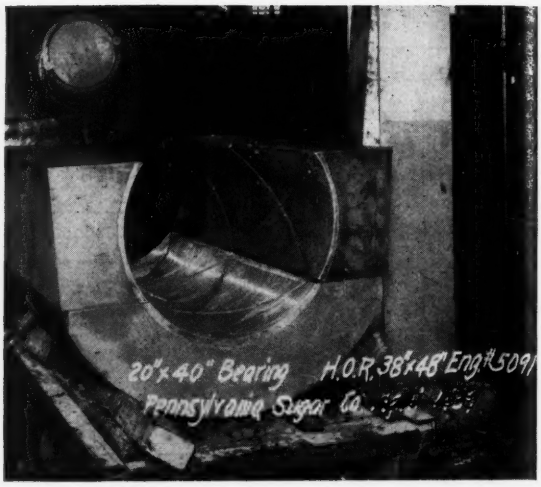


Fig. 2. A view of the new bearing in place ready to be placed in position

Quick Repair of a Large Engine Bearing

THE PROCEDURE involved in removing a damaged bearing from a large and heavy machine and replacing it with a new or repaired one often calls for considerable ingenuity. These days when the high speed turbine has all but supplanted the large reciprocating steam engine, the steam engineer is not called upon to replace large bearings as often as used to be the case, but there are still many of these old engines left and bearings still have to be replaced and repaired.

One of the places in this country where such jobs are handled as little more than routine matters is at the Pennsylvania Sugar Refinery in Philadelphia where Dan Gutleben is Chief Engineer. Those of you who are addicted to reading the Practical Engineer section of this magazine may remember his exercise chart which we published sometime ago. We first ran across this chart while looking through Dan's famous "Log," that most interesting volume of human and technical interest in which is recorded all that happens in the Pennsylvania Sugar Plant or for that matter, in the vicinity of Shackamaxon Avenue.

It was while looking through the "Log" that we also happened to see this account of a main bearing failure on one of the large engines in the power plant. So we asked Dan for a copy and here it is.

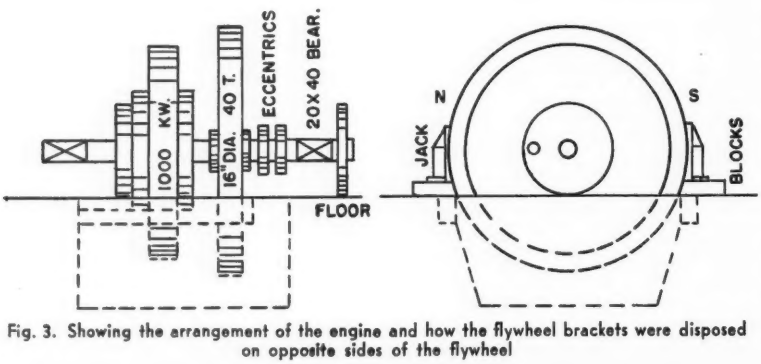


Fig. 3. Showing the arrangement of the engine and how the flywheel brackets were disposed on opposite sides of the flywheel

Bearing in Service 17 Yr

The engine is an old 38 by 48 in. horizontal Corliss which has been in service for many years. As reported in the log, for 17 yr the main bearing, 20 by 40 in., carried on valiantly. During the 92,000 hr of operation, the perimeter of the shaft which drags on the babbitt had traveled some 550,000 mi while carrying a weight of 120,000 lb. Dragging so much weight for so many miles is enough to wear out many things far more rugged than a babbitted bearing and so it was no great wonder that one morning after 16 yr of operation, just after the load was put on the engine, smoke was seen to be issuing from the bearing.

The bearing was found to be very hot and so "the boys" poured cold oil on it by the bucketful, adding by way of a purgative a small amount of pulverized mica. All this was of little avail, however, and at 11:30 the bearing ran

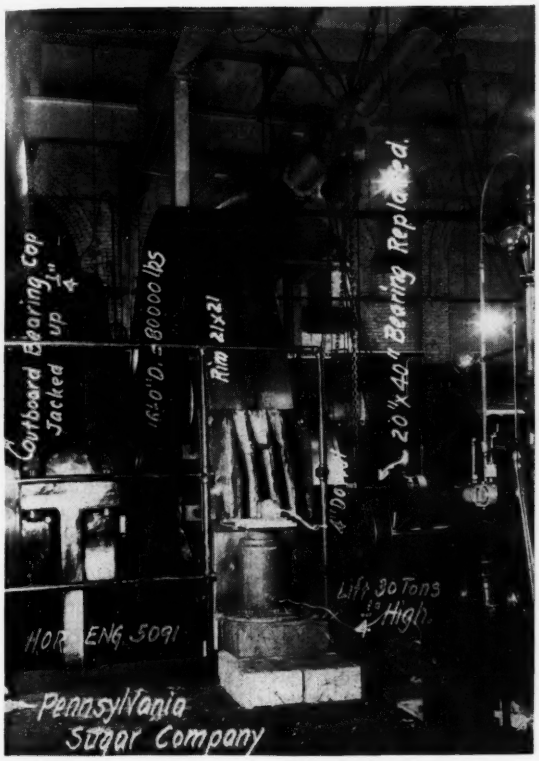

Outboard Bearing Cap Jacked up 1" 1/4
16'0" D. = 80000 lbs
Rim 21x21
20 1/4 x 40" Bearing Replaced
Lift 30 Tons 1 3/4" High
HOR ENG 5091
Pennsylvania Sugar Company

Fig. 4. General view of the engine while the job of repair was in progress

Fig. 5. A close-up showing the construction of the flywheel brackets and the method of attaching them to the flywheel

a temperature of 160 deg and it threatened to go higher. The load was then taken off and the engine allowed to idle until 1 o'clock to cool off, and the bearing removed. Thirteen hours later, the throttle was opened again and after warming for 2 hr the engine was back in service.

Method Used in Making the Repair

The reason for this remarkably short time for repair lay in several previous indications of trouble and consequent foresight in that respect. The time of the bearing failure was in May. Some slight distress had been observed the previous December and also in March, but in both of these instances an increase of cool oil circulation had restrained the heat. An opportunity of an idle week-end was criminally allowed to slip by. Then one sugar move after another kept the works going week after week until the failure occurred. The accompanying photographs show that by the grace of Providence another case of neglectfulness was passed without loss.

The tool by means of which this remarkable time of repair was made consisted of a pair of brackets made a month before in anticipation of the emergency. These brackets, assembled from pieces of steel plate by welding, were clamped to the rim of the flywheel at the opposite ends of the horizontal diameter to serve as shoulders for the two hydraulic jacks shown in the pictures. This arrangement permitted easing the load off the bearing without removing the eccentrics or dismantling any of the engine parts. The arrangement of the bearings with respect to the other parts of the machine is shown in the diagram, Fig. 3.

The main bearing cap, of course, had to be taken off and the outboard bearing cap was lifted ⅛ in. by means of the bearing screws. While this was in progress, the blocks, brackets and jacks were set and the actual lifting required 1 min. The total lift was ¼ in. The bottom bearing was rolled out 3 hr after the job was started. The fitting and scraping of the new bearings required about 6 hr.

The work involved 112 hr of labor on the part of the plant crew together with 93 hr of labor from an outside contractor who supplied certain parts of the equipment. The two brackets cost $197 to make and the entire job, allowing for a credit of $425 from the insurance company, was done at a cost of $623.36.

Itemized, the actual costs were as follows:

2 Brackets (350 lb each)	$197.00
Labor 93 hr + Equipment (Outside Contractor)	324.27
Plant crew 112 hr	95.16
Rebabbitting old bearings	421.93
	$1048.36
Credit from insurance company	425.00
Total cost	623.36
Rebabbitting and turning bull-ring	$132.41

Welding Rods for Steel

INSTEAD OF GOING into detail, a general rule for the filler rod to use with steel can be given: use the rod most nearly like the metal to be welded.

Mild steel is the easiest to weld, the difficulty increasing with the carbon content. Cast-iron flux should be used on steels of high carbon content and if the same hardness is wanted in the weld a welding rod of high carbon content should be used. Become a good welder of mild steel before attempting the welding of high carbon steel.

The Green Mountain Hydroelectric Power Plant

New project of U. S. Bureau of Reclamation includes dam 270 ft high, 1300 ft long diverting water for irrigation, and power house containing two 12,000-kva hydroelectric generating units. This article gives full details of turbines, generators, governors, penstocks and water control equipment. Turbine scroll cases were installed by the Bureau's internal-hydraulic-pressure method.

By A. W. SCHMIDT, *Engineer U. S. Bureau of Reclamation*

ADDITIONAL POWER for war purposes will be supplied by this new hydroelectric power plant now being placed in operation by the Bureau of Reclamation. This plant and dam are the first completed major units of a multi-purpose power and irrigation project, which is to divert water from a western river through a tunnel under the Continental Divide and make it available for irrigation of lands east of the Rocky Mountains.

General Arrangement

General arrangement of the dam, outlet works, and power plant is shown in Fig. 1. The dam is 1300 ft long at the crest, has a maximum height of 270 ft above the bed of the river, and contains approximately 4,000,000 cu yd of graded material. The main body of the dam consists of a moistened and rolled embankment of clay, sand, and gravel. The upstream slope of the embankment is covered with rock riprap. The downstream portion of the dam is composed of a semipervious rolled embankment covered by a section of cobble and rock fill. Three 10-ft concrete cut-off walls extend into bedrock and act as a barrier to prevent seepage of water along the bottom of the dam. The reservoir capacity is approximately 150,000 acre-ft, and its area is 2100 acres at maximum water surface.

Outlet works consist of a cylindrical trashrack structure at the inlet, connected to a gate chamber by an 18-ft diameter circular concrete tunnel approximately 800 ft long. To eliminate ice collecting on the trashrack, the intake structure was placed so that the entire structure is below the minimum water surface. From the gate chamber, two 102-in. diameter penstocks furnish water to the turbines and outlet valve. The penstocks are installed in a concrete-lined, horseshoe-shaped tunnel 15 ft 9 in. high, 23 ft 3 in. wide, and approximately 710 ft long. This tunnel is located in the rock of the east abutment and was used during the construction of the dam for diverting the river around the dam. These tunnels are shown in Fig. 2.

A concrete-lined, open-channel spillway, approximately 1100 ft long, constructed along the west abutment of the dam has a discharge capacity of 25,000 sec-ft. After the war three radial gates, each 25 ft long and 22 ft wide, will be installed to control the discharge of the spillway and the reservoir level.

Plant Arrangement

The power plant is of reinforced concrete construction approximately 70 ft wide by 100 ft long. It contains two vertical-type generating units, control and station-service equipment, a small machine shop, two outlet valves, and oil treatment and storage facilities. A service area has been provided at the end of the plant adjacent to the switchyard. Transformers can be moved into this area, through a large accordion-type door, by a transfer car operating on a track. The generating room is equipped with a 50-ton overhead traveling crane which has both main and auxiliary hoists. Natural lighting for the interior of the generating room is provided by panels of glass blocks.

Turbines

The turbines are Newport News Shipbuilding & Dry Dock Co. Francis-type units with riveted plate-steel spiral casings. Each turbine is rated at 15,000 hp at 203 ft effective head and operates at 257 rpm. The turbine runners are single-piece steel castings. The water discharge for rated load varies from 850 cfs at 186-ft head to 470 cfs at maximum head of 261 ft.

These scroll cases were embedded in concrete, using the internal-hydraulic-pressure method developed by the Bureau of Reclamation. The castings were assembled in place while supported by jacks, and temporary bulkheads were installed closing the penstock inlet and speed-ring openings. While the cases were being concreted and grouted, water pressure within the casing was maintained at operating pressure, thus expanding the casing to normal size and distributing the load properly between the steel turbine casing and the surrounding concrete. This pro-

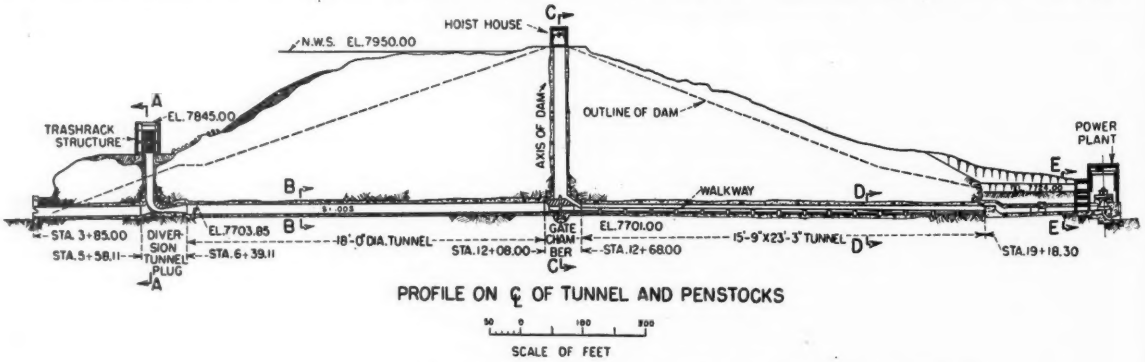


Fig. 1. General arrangement of dam, outlook works and power plant at Green Mountain development

cedure eliminates overstressing and cracking of the concrete.

Governors

Governors are Woodward oil-pressure, relay-valve, actuator-type with electrically driven speed-responsive elements. Each governor is of the cabinet type containing actuator and control, a motor-driven pumping unit, and sump tank. A pressure tank is placed adjacent to each cabinet. The two governors are so arranged that either or both pressure and sump systems can be used for both generating units. An operating oil pressure of 200 psi is used to control the turbine wicket gates by two double-acting servomotors.

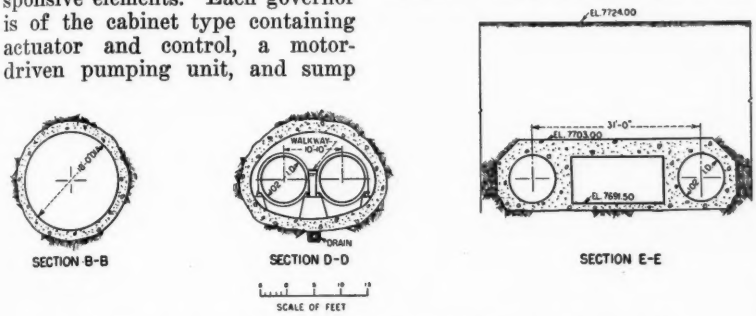


Fig. 2. Cross-sections through tunnels and penstocks at locations indicated on Fig. 1.

Generators

Main generators are Allis-Chalmers Mfg. Co. vertical-shaft, water-wheel type units. Each generator is rated at 12,000 kva at 0.9 pf, 6900 v, three-phase, 60 cycles, 257 rpm. They are of the totally enclosed water-cooled type. The stator insulation is all Class "B" or inorganic and the generator is rated for a maximum operating temperature of 100 C (212 F) with an ambient temperature of 40 C (104 F). Each generator has two guide bearings and a thrust bearing of the Kingsbury type located above the rotor. All bearings have self-contained oil reservoirs and oil circulating systems.

Generators have a flywheel effect of 2,000,000 lb at 1 ft radius and are designed to withstand the maximum run-away speed of the turbines. Each generator is equipped with an automatic carbon-dioxide fire-protective system. Air-operated brakes have been provided which are capable of bringing the rotor to a stop from half speed in five minutes. These brakes can also be used as hydraulic jacks to lift the rotor off the thrust bearing when connected to a hand-operated high-pressure oil pump.

The excitation system is designed for a speed of response of not less than 0.5. Each generator is provided with a Westinghouse automatic voltage regulator of a type wherein small changes in generator voltage are corrected by adjustment of the exciter-field rheostat but large changes in generator voltage are adjusted by quick-response vibrating contactors connected across blocks of field resistance. Each machine has a direct-connected exciter and pilot exciter mounted on the upper end of the main generator shaft.

Transformer and Switching Station

Each generator is connected directly to a bank of step-up transformers. These transformers are rated 4000 kva, single-phase, 6900 Δ-to-69,000 Y-v. A third bank of 24,000-kva capacity is used to connect the 115-kv outgoing line to the 69-kv bus. These transformers are equipped with automatic tap-changing-under-load. All transformers are of the oil-immersed, self-cooled, outdoor type and are mounted on single-flanged wheels and rails so that they can be readily moved on a transfer car.

Five oil circuit breakers, rated 69 kv, 600 amp, 500,000 kva interrupting capacity, are used for switching. The breakers are equipped with bushing current transformers which are used for current indication and relaying. Three coupling capacitors are connected to each of the two outgoing lines to provide potential for relaying and indication and for the carrier-current communication system. In order to minimize the use of critical war materials, all supporting structures in the switching station are constructed of wood. All bushings and insulators are of the high-altitude type.

Hydraulic Valves and Penstocks

Two 102-in. diameter ring-seal gates are provided for isolating the plant from the reservoir. The bodies of these gates have been embedded in concrete and are used as penstock inlets. A vertical shaft approximately 240 ft high and 20 ft in diameter provides access to the valve chamber. At the top of this shaft is a hoist house equipped with a 25-ton traveling crane. The ring-seal gates can be opened only under balanced pressure but may be closed under a full unbalanced reservoir head of 242 ft, with an unrestricted flow of water through the penstocks. They are unique in that there is no sliding motion in the valve. The seal action is axial and is not applied until the motion of the gate leaf has stopped. The seal ring is mounted in a synthetic-rubber diaphragm and is moved against its seat by unbalanced hydraulic pressure. The unbalanced thrust on the gate leaf is taken on trains of rollers.

The two penstocks are constructed of welded steel plate. Their lengths are approximately 830 and 850 ft. The welding of all seams was checked by photographing each seam with x-ray equipment, except that radium was used to photograph the final closure joints. Defects in the welds were chipped or ground out and then rewelded. From each penstock a 44-in. branch outlet connects to a discharge valve. The two 44-in. tube valves permit the release of water for flood-control purposes. These are regulating-valves arranged for free discharge.

Control and Protective Systems

Centralized control for the power plant and switchyard is located in a glassed-in control room. The main control board is composed of vertical steel panels containing the indicating instruments and control devices. The rear panels contain the protective relays. All control cables emanating from this board are multiple-conductor lead-covered and are run in open trays to the generators, voltage regulators and similar equipment.

Each unit is arranged for normal starting and stopping from the governor. Automatic shut-down is provided in event of trouble. Each generator and transformer is protected by induction-type ratio-differential relays arranged to trip the necessary circuits. The generators are operated with ungrounded neutrals. Induction-type ground detectors are provided to annunciate if the generator neutral potential varies from ground potential by more than 15 per cent of generator line to neutral voltage. The two outgoing lines are protected by high-speed, zoned, directional impedance relays. The 69-kv line has directional ground relays. Ground relays are not required for the 115-kv line, normally operated ungrounded.

Shipshaw on Saguenay to Develop 1,500,000 hp

WHEN THE INSTALLATION of twelve generating units in No. 2 power house of Aluminum Co. of Canada, Ltd.'s hydroelectric development at Shipshaw on the Saguenay River in Canada is completed late this fall as planned, it will make available a total of 1,500,000 hp, or 1,140,000 kw of electric power for the production of aluminum by this company.

In the No. 1 Power House at Chute a Caron, four hydroelectric generating units, each rated at 65,000 hp, were put into operation between January 1931 and January 1934. Those units have since been rebuilt with larger water wheel runners and now produce 75,000 hp each. Two additional units were installed in No. 1 Power House in February and April 1942. These two units are scheduled to be moved to the No. 2 Power House in August and November 1943 to form No. 11 and No. 12 units at the latter.

Clearing of the site, preliminary layout and installation of construction equipment on the No. 2 project was begun during the summer of 1941 and the first generating unit was started on November 23, 1942. In the No. 2 Power House, 12 units, each rated at 100,000 hp each, including the two removed from No. 1 Power House, will be installed. Two of these units went into operation in November 1942 and the schedule calls for the installation of one additional unit each month thereafter until the total of 12 units is completed.

Thus, when the development is completed, the total installed capacity will be: No. 1 Power House, 300,000 hp; No. 2 Power House, 1,200,000 hp; total 1,500,000 hp.

Cost of the first stage of the Shipshaw development, including No. 1 Dam and No. 1 Power House with four units was $35,100,000. Cost of the extension to No. 1, $4,700,000. The estimated cost of the second stage of the Shipshaw development, including Dams Nos. 2 to 5, Pass Dangerous Dam and No. 2 Power House with 12 units, $65,900,000. Total cost $105,700,000.

According to the Aluminum Co. of Canada, the estimated cost is practically double what it would have been in peace time because of the higher wage rate, the greatly increased labor force with overtime and Sunday work, the double amount of equipment necessary and the lower grade of labor available, all of which were necessary for completing the project with the required speed, but at the same time lowered the efficiency of construction work.

As a result of this construction, the Saguenay River now flows through a canal formed partly by excavation through solid rock, and partly by concrete dams. This canal is a little over one and a half miles long. It has a minimum width of 300 ft and a minimum depth of 33 ft.

The intake structure or headblock at the down stream end of the canal is built of mass concrete and contains 12 steel headgates. From the headblock, the water flows to the turbines through six tunnels, each 30 ft in diameter, excavated through solid rock and lined with concrete. Effective operating head is 208 ft and the water is discharged into the tailrace at tidewater.

The No. 2 Power House is of concrete, 800 ft long and of semi-modernistic design.

All equipment in the power house is being manufactured in Canada. Turbines are being built and installed by Canadian Allis-Chalmers Ltd. and S. Morgan Smith Canada Ltd.; the generators by Canadian General Electric Co. Ltd. and Canadian Westinghouse Co. Ltd.; transformers by Canadian General Electric Co. Ltd. and English Electric Co. of Canada Ltd.; and the control equipment and switchboard by Canadian Westinghouse Co. Ltd.

Photos courtesy of Canadian National Film Board.

Fig. 1. View of No. 2 Power House at Shipshaw under construction, with tailrace discharging to original river bed

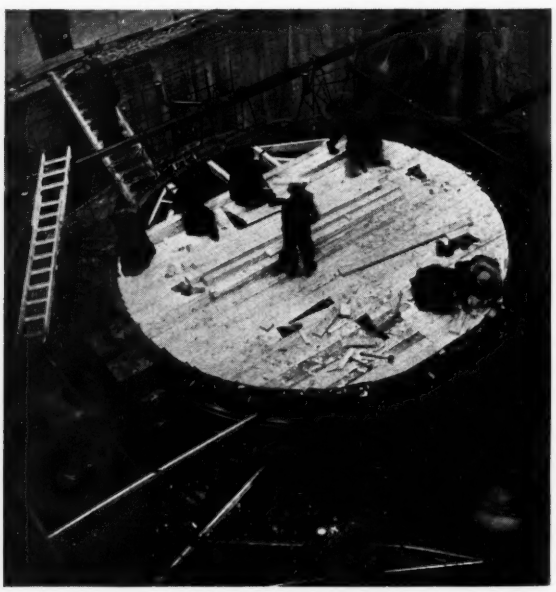


Fig. 2. At work on the scroll case of No. 9 generating unit. According to schedule, this unit should be in operation now

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

DO POWER ENGINEERS HAVE SPECIFIC POST-WAR PLANS?

"Sure I know we've got to win the war first. But how many power engineers have any idea of what they're going to do after the fighting stops? Not many, I'd guess.

"If the fighting stopped next month how many power engineers would be prepared to go to the management and say 'Here's our present situation. We've got to have a new high-pressure boiler (or pump or turbine-generator or deaerating heater or perhaps a whole new plant) if we are to generate low-cost steam and power in the future. Here's what we ought to do. Here's what it will cost. Here's what the results will be. Here's how we'll get our money back on the deal. Here's how we'll benefit in operation.'

"Let's have more specific plans, less planning. Only in this way can power engineers prove that they have the tremendous stored-up demand for new construction and modernization that we all know exists. Let's do that instead of worrying about the international situation.

"Industry will probably ask, 'But where's the money coming from and why should we spend it for that?' One answer is, 'Nobody can make you, but if you don't decide that you're going to do it somehow, in every part of every business, the question of your profits will be purely academic—not to say historical.' But without a definite plan, the engineer can't give any answer to that question.

"Why don't you publish in The Practical Engineer some specific post-war plans for individual power plants? Let's get very practical."—Service Sam.

Well, why don't we? Let's have the specific plans. We'll publish 'em. I was just about to write something on this when the above letter came in from a manufacturer's service engineer.—A.W.K.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

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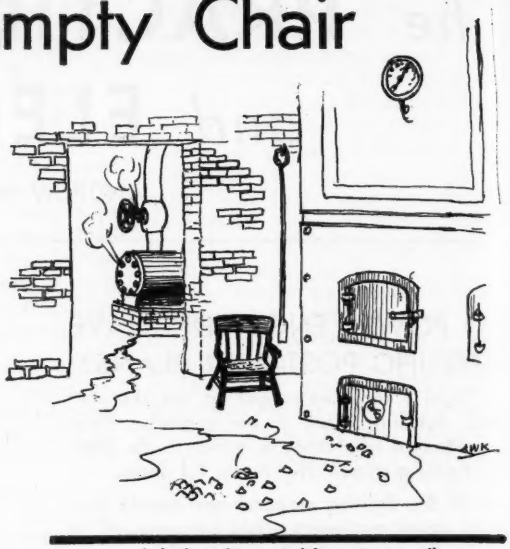
The Story of the Empty Chair

By WM. F. HEIWIG

It may seem incredible to those not familiar with the type of small plant described in this article that the coal consumption of any boiler installation could be reduced to less than one-half by simply plugging up the leaks, yet this is a true story. Plants such as this are not uncommon. Dilapidated, gloomy and neglected, about all the operators have time for is to keep these plants running. High fuel consumptions are accepted as a matter of course, yet, as pointed out here, a little attention to details would result in remarkable savings. To those who know, the pathetic humor of this little narrative makes it more realistic.



It had not been used for quite a spell

SOME TIME ago, I was called in by the manager of a small corn products plant to see if I could offer any suggestions which might, if put into effect, improve the condition of his power plant.

The plant consisted of one horizontal return tubular boiler, 72 in. by 18 ft with a builder's rating of 150 hp, one piston valve steam engine, 16 by 18 in., with a builder's rating of 125 hp, two steam driven boiler-feed pumps and one open feedwater heater. The water used for boiler feed was city water.

Perpetual Motion

To get a preliminary picture of the situation, I went into the plant and sat down in a cane-bottom chair which, judging from the layer of dust on the seat, had not been used for quite a spell. From this point of vantage, I surveyed the situation. I should have had a movie camera because I have never seen quite so much motion in any one place in my life. The engineer was also the fireman and, Boy, was he busy! He almost succeeded in being in two places at the same time. No fireman on a drag locomotive ever shoveled any more coal than this poor fellow was doing. He would heave in a load of fuel, quickly look at the steam gage and then run, lickety split, into the engine room. There, he would look around, probably to see whether the engine was still there, come back, grab the scoop and let her (the boiler) have it again. What this chap needed was a pair of roller skates.

"This is sure some job you have here," I remarked, by way of breaking the ice. "How long has it been this way?"

Between firing operations I was able to learn that it had been coming on slowly, that when he took the job, he could sit down occasionally and rest. That, however, was a long time ago but now he did not have time for anything except the scoop shovel. He looked worn and disheartened.

"You will not be offended if I look around a bit, will you?" I asked him after a little while.

"Hell no," he said, "I only hope that you can do something to help."

He would heave in a load of fuel and then run, lickety split, to the engine room

I looked at his fire and will say that for a hand-fired job, he certainly had it on any fire in a steel melting furnace. It was hot.

I asked him if he always ran with his stack damper wide open and his reply was, "Wish to Hell I had twenty more feet of stack." He needed all the draft he could get and what he got was not enough.

After looking around for two hours or more, I told him I would be seeing him later and looked up the manager. I told him that I thought with the help of his engineer I would be able to make his plant a little more pleasant and somewhat more economical. He thought that would be nice but warned me that he could not shut down for any repairs at the present time and whatever I did would have to be done on week-ends, to which I agreed.

We Begin Work

So we started in. The first thing we did was to take cotton waste and fire clay and with the help of a hand torch went carefully over the boiler setting. We filled all the cracks and after these were filled we troweled on a coat of asbestos plastic cement with a tar binder and called it a week-end.

As the next week-end was the time for the regular boiler wash-out, it gave me a good chance to look over the boiler. This inspection disclosed some 35 tubes to be leaking badly in the rear head. These had wasted away so badly that to try and roll them was out of the question. Also, I had noticed that the safety valve would start to blow at 85 lb gage instead of the 110 lb it was set for. So I removed the safety valve and found the seat badly cut. After repairing the valve and replacing it on the boiler, with the same spring load as when I removed it, I told the engineer to watch and not run his pressure over 110 lb gage as I

would be back and adjust the blow-back ring for the proper blow-back.

He said, "Hell, don't worry about too much steam pressure, I do damn well to keep it high enough to run on."

The Empty Chair Is Filled

On Monday morning, I went back to adjust the blow-back ring on the safety valve and when I came into the boiler room, believe it or not, there was the engineer sitting in the cane-bottom chair.

"What's wrong?" I asked him. "You are sitting down."

The only reply I received was a broad grin.

The next week-end, we removed the bad tubes and replaced them with new ones, but the mill started up late that Monday morning. It was quite a week-end. After we got things under way, I suggested adjusting the hand damper so that it would provide just enough draft to handle the load. Of course, without draft gages, we had to play with it for quite a while but finally we arrived at a setting where it worked fine. This proved to be about 5/8 open.

As we had worked quite hard several week-ends, I suggested to the engineer that we take the next week-end off. He was beginning to see the results of his labor, however, and preferred to go on until the job was complete. So the following week-end was spent repacking all valves, water ends, boiler-feed pumps and facing up of pump valves.

As things were running along better now, I had more chance to talk to the engineer and learn about some of his operating problems. We placed a gage on the exhaust pipe from the engine and found that the engine was operating against 15 lb gage back pressure caused by a reduced exhaust pipe.

After changing the exhaust line to one of proper size, the back-pressure gage read 1 lb.

By this time things were running along pretty nicely and the engineer was spending his spare time cleaning up the plant. He had never had time to do this before. We found a light knock in the engine crank-pin box and after taking the rod down we found that the babbitt in the brasses had at some time or other been good and hot and as a consequence, was flaking off in small pieces. So we went to work; we poured new babbitt and then scraped it carefully. This cleared up all the trouble.

As a result of our work, the coal consumption had dropped from 7 tons in 12 hr to 3 tons, plus, of course, the corn cobs from the corn sheller which had always been used as fuel.

After doing a few more small jobs such as cleaning lubricators and grinding check valves on the boiler-feed line, I asked the engineer if he thought we had done a good job.

His reply was quick and characteristic, "Hell, yes, it sure is, and I will bet that it don't get into such a mess again as long as I am here."

Needless to add, the manager of the plant was also pleased.

Maybe So

By Guillermo Pablo

SLOWLY THE MINUTE hand drags itself around the face of the clock. And more slowly follows the hour hand. While others are deep in the arms of Morpheus I must sit here and listen to the whine of the gears from that speed reducer, the hum of the M.G. set, the click of the compressor valves and the groan of the pump. Not only listen but from time to time inspect the different pieces of equipment to see that each is doing its stuff. All this so often that it becomes second nature and leaves my mind free to wander. Just at the moment it turns to the talk with Harry James who came to us a few months ago from the Larkin Manufacturing Co. Nice boy, Harry, and does his work well. Tonight he had a gripe about the way we burn oil. This plant burns surplus gas. We are shunted to oil when the gas supply is short. This happens so seldom that it was not considered worth the cost to make some refinements. It follows that the firemen have more to do and they are inclined to get pessimistic. A trip into the boiler room at that time is to receive enlightenment on what is wrong with the world. Tonight Harry was in good form and I heard plenty. And I added my twenty-five cents worth. "Fair enough, Harry. What's the matter with our way of doing? Doesn't the oil burn? Isn't the color of the smoke from the stack all right? Aren't the boiler surfaces clean? Those things mean something with an oil fire. Aren't we evaporating enough water for the amount of oil we burn? In short, isn't our boiler efficiency reasonably good? Oh, by the way, what was the set-up at the Larkin Co.? How old was the equipment? Ideas and methods change with time, you know. What was the efficiency and boiler loading there? Because that way suited the conditions at Larkin, what makes you think they would suit here? From what you tell me I suspect that in your three years there you learned to handle the equipment very well. You were at home with it. Here it is strange and you have not yet acquired the proficiency which will give a comfortable 'at home' feeling. And Harry, did you ever stop to realize that some of the changes you think should be made have been tried, as well as others you have not thought of? For one reason or another they did not suit this plant and so were abandoned or never tried. Some good ideas were stopped dead when they met

"Mr. Milligan will see you in a moment, he's taking a steam bath."

the warden of the treasury. In other words, the boss would not spend the money to put them into effect."

And while this orchestra plays on I muse on other Harrys I have met who were prone to criticize and criticize without the facts of the case being fully known. Guess I have done some on my own account. Also I notice the age of the person does not make as much difference as one would think it should. Possibly some of it is based on the quirk of human nature that makes us all resist a change. Well, the clock says I must make a change and get another compressor on the line for the hired help is going to use more air very soon.

FOR THE BOILER OPERATOR

Boiler Feedwater Control and Its Effect on Boiler Capacity

This short account of experiences in a boiler plant may suggest methods of curing trouble in other plants

By R. C. BAKER
Clearwater, N. C.

SOME YEARS ago I took over the job of operating three 500-hp boilers in a textile plant. I was informed the job was tough due to lack of boiler capacity and a load which was extremely variable.

After looking over the boiler and process plant for some time, I began to get the idea that the load variation might be due to trouble at the boiler plant rather than at the process plant.

In order to check this we removed one of the flow meters from one of the boilers and by means of a home-made orifice, placed in the steam main, we were able to check the variation in flow. Our orifice calculations were way off but simply as a device for showing load variation we got good results.

When these experiments were discussed with the manager he immediately approved the purchase of a flow meter for this line. Frankly, I don't know whether he approved the purchase because he had very little faith in our experiment and I think he expected to put us in our proper place by showing us that a large variation did exist. He actually believed this, but wanted it confirmed by installing a properly engineered flow meter for the job.

Regardless of what he really thought the meter showed that we actually had a very constant load. In all fairness to the manager it must be pointed out that later on we found that at one time the dye house, requiring a large percentage of the steam generated, did cause considerable variation. This idea had been called to the manager's attention so often that it was hard for him to believe otherwise.

Satisfied that the greater part of the trouble was at the boiler house, we started looking for it.

One of the first things we found was that the feedwater regulators were operating improperly. The brackets holding the expansion tubes of the regulators were fitted to the brick boiler walls with anchor bolts. These had worked loose. Each time the regulator tended to correct the water level, part of the motion would be lost in the loose bolts. A little later in the cycle the bolts would hold. With all this lost motion the regulators could do nothing. First the water would be very low, then high. With a few pieces of flat iron and clamps we made a single unit, so to speak, of the expansion tube bracket and the pipe line supporting the feedwater valve proper.

After that, all the motion was imparted directly to the valve and the water level stayed within plus or minus 1½ in.

We next tackled the feedwater heater which was also too small for the job. It was found that for about 60 per cent of the time the heater received nothing but 212 F condensate, and the remaining 40 per cent of the time make-up only at atmospheric temperature would enter the heater. This meant that for 60 per cent of the time the heater had hardly anything to do. Stated another way, it could have been working for 60 per cent of the time and wasn't. During this time pressure would build up in the heater from the boiler feed pump exhaust, this steam would be relieved to the atmosphere and wasted. At this part of the cycle the feedwater temperature would rise to around 220 F. Since the feed pumps worked under a small positive head, around 6 ft, they would become vapor locked and trip out. The remaining 40 per cent of the time with make-up entering at, say, 60 F it was impossible to heat the water more than 40 F at the rate of 50,000 to 60,000 lb per hr. At that instant instead of a pressure in the heater a vacuum was formed drawing in air, thus preventing any deaeration.

The heater tie rods had become so loose that you could see the heater breathe each time the internal condition swung from a pressure to a vacuum.

With first a shot of cold water reaching the heater, then a larger shot of hot, the temperature regulator went crazy, it didn't know what to do.

There is a reason, beyond the scope of this article, why the feedwater was made to enter the heater as described above although it only took into consideration the protection of a pipe line and not the operation of the boilers.

By rearranging the heater and hotwell float valves we managed to get the make-up and condensate to enter the heater together in their proper proportions.

We next installed a pressure regulator on the heater, instead of the thermostatic, for temperature control. This regulator kept the temperature at 212 F so constantly that everyone doubted the accuracy of the temperature recorder we borrowed from the process plant. They were only convinced when a laboratory type of glass thermometer was placed in a well in the same feedwater line.

As a result of these changes the boilers, which were too small for the job, acted as though they had been given vitamins for they suddenly handled the load with ease. The boiler water level under normal conditions never varied more than plus or minus ¾ in., the feedwater pumps never tripped out on overspeed, the heater didn't sound as though it was going to blow up, the boiler pressure stayed up, the fireman had a much easier job, the furnace maintenance was less, there was practically zero oxygen in the feedwater and last but not least we had a much wider choice of coals.

Prior to this we were limited to two or three premium coals having a high ash fusion. This is accounted for as follows: When only cold water was entering the boilers they were forced to their limit to maintain pressure, a roaring fire was in the furnace. Shortly afterwards with only hot water entering, the damper regulator would close, building up a positive pressure in the furnace, melting the ash as well as grate bars.

With these swings in temperature extremes eliminated, we found that cheaper coals with lower ash fusion temperature worked satisfactorily.

Everything was now working as it should, so we found it unnecessary to operate the large induced draft fan which was installed to help maintain pressure under peak conditions as well as to save grates.

The discouraging part of our work was that although we showed a reduction in the cost per ton of coal and maintenance, the evaporation according to the records stayed just about the same. One reason for this was, the cheaper coal contained less heat; another was that prior to the changes, each time the pressure would drop from 250 psi to 200 and lower, the flow meters would indicate an increased steam flow as the flow meters were designed for 250 psi and no correction was applied.

We had to be satisfied with just about the same evaporation and console ourselves with the fact that since we were maintaining the same evaporation with inferior coal and at a higher pressure, we were saving money. We did think at one time we would be able to compare actual coal consumed one year with that of another, but it so happened that plant operation was so altered that we had no basis for comparison.

One other change made which helped assuage the worries of the firemen and

engineers was to replace the individual differential pressure regulators on each boiler feed pump with a hydraulically operated regulator controlling all pumps as a unit. We did this at a minimum cost by working out a way of using the same steam valves, eliminating their differential mechanism and operating them by means of the hydraulic regulator. This wasn't as simple as it might seem as each steam valve had different characteristics as well as lever arm travel.

Some of the disadvantages of the old regulators were that one particular part always gave trouble. The part cost around $10.00 and had to be replaced on an average of once each month. It is true poor or rather improper operation caused most of the failures, but since we seemed never to be able to prevent this we decided it would be best to replace it with something improper operation didn't damage. We also found the packing on these regulators had to be just so in order to get best regulation, even this was nothing to write home about. The best we could get these regulators to do was to hold a differential of between 35 and 50 psi.

The most serious objection we had to these individual regulators was hunting between pumps, while trying to operate two or more in parallel. With the one hydraulic differential regulator and means of readily proportioning the load between each pump it was impossible to cause hunting.

With boiler operation mostly a matter of watching, it left the men with a chance to properly care for feedwater treatment and other less strenuous duties. We found it a simple matter to keep men on the job whereas previously it had been a problem.

PRACTICAL HINTS AND KINKS

Aids in Holding Work in Machine Shops

The three arrangements for holding work during cutting or machining operations were all developed in the Schenectady shops of The General Electric Co. They have been found effective and practical and are presented here for any one who may find use for them in his shop.

THE simple angle-iron fixture shown in Fig. 1 developed at General Electric's Schenectady Works overcomes the problem of misalignment in cutting the keyways in a 3-in. dia 6-ft long cam shaft, and permits a small machine to do a job ordinarily requiring a large spliner.

Previously, even with the utmost care the operator was unable to machine the keyways so that they did not need correction. Most of the error was caused by the fact that only one or two keyways could be cut with one setup.

The angle-iron fixture which eliminated these difficulties was planed on its four surfaces, and clamps were made for holding the shaft in place in the angle. Two keyways are cut, and then the shaft and fixture moved along in the vee blocks to the next setting. With the work done while the shaft is held in the fixture, the keyways are in line and remain that way after the shaft is straightened.

Holds Bearings Firmly for More Accurate Machining

The holding fixture shown in Fig. 2 makes possible speedier and more accurate boring, turning, and facing of split-type ball seat bearings for a high-speed machine. The fixture has three parts. Part one has a tapered shank to fit the lathe spindle and a ball seat fit to receive the bearing. Its outside diameter is threaded for a holding nut, part two. Part three is a center which fits the tailstock.

In a routine setup the tapered shank of the fixture is slid into the lathe head,

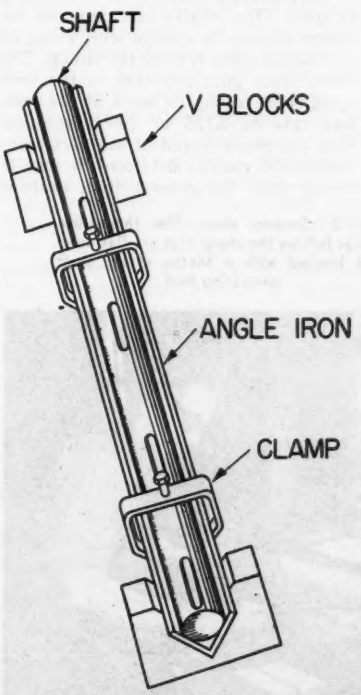


Fig. 1. Angle-iron fixture for holding shafting

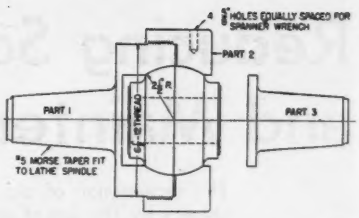


Fig. 2. Fixture to hold bearings for machining

and the bearing is placed in the ball seat fit. The holding nut is then put on and tightened by hand. The flanged center is placed in the tailstock and tightened against the face of the bearing so that it is absolutely square with the machine. The holding nut is then tightened with a wrench and with the tailstock pushed out of the way, the part is in position for boring.

Previously these bearings were held in position by the four-jawed chuck of the lathe. This required the indicating of the ball seat and face, and adjustments were made by tightening the jaws of the chuck, which might spring the bearing.

Positive Clamp Frees Table Space

The old system of clamping work to machine tables by means of "U" clamps has been displaced in some applications at General Electric's Schenectady Works as the result of a clamping fixture suggested by one of the company's workers which has many advantages.

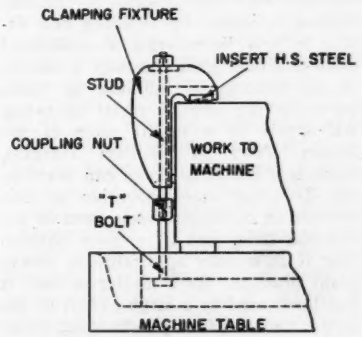


Fig. 3. Positive clamp frees table space

The fixture is a positive clamp with an inserted hardened steel jaw to prevent slipping. The "T" bolt is fitted with a coupling nut so that by varying the length of the stud used, the clamp may be employed on varying thicknesses of work. Since but a negligible amount of space is needed for fitting the "T" bolt into the table, its full length can be utilized. Previously, blocks to support the "U" clamps took up considerable working space.

The clamping fixture is being used successfully on boring mills, planers, and milling machines—and the old "U" clamp supports have gone into the scrap pile.

Reducing Scrap Piles and Maintenance Costs

The reclamation of old and worn-out parts of machinery by the use of metal spraying offers unusual opportunities for reducing maintenance costs in many plants and at the same time permits equipment to be kept running. Photographs furnished by Metallizing Engineering Co., Inc.

THERE is little need to repeat here what we all know about the importance of scrap metal. Our very existence depends upon the ability of every one of us to keep the steel mills and foundries fed with precious junk. But in this scrap drive as in all things it is necessary to use discretion. By junking parts that can be salvaged we are defeating WPB's program and throttling our own individual part in the war effort.

This sounds reasonable, yet thousands of tons of still valuable shafts, spindles, pistons, rods, crank shafts, etc., are still being heedlessly thrown into the scrap pile because they are worn.

Most power plant operators are familiar with the process of reconditioning cylinders by reboring and fitting in new liners—this is considered good practice. Less common, however, is the process of building up worn parts by the use of metal spraying. An article in a recent issue of the Metco News by William Hargest, Associate Editor of American Machinist, describes the application of this method of salvaging worn parts in the railroad field, and it is quite obvious that it is equally applicable in power plant practice. As a matter of fact, it has been used to a large extent in the power field, especially in keeping steam turbines in service.

As pointed out in Mr. Hargest's article, a survey of five Eastern railroads shows that parts which otherwise would have been scrapped are being reclaimed by metallizing at from 3 to 25 per cent of their original cost; also that the service life of the metallized parts often exceeds that of the original installation. The latter fact was found to be especially true of those parts requiring lubrication, such as pistons, shafts, and bearings, because the structure of the sprayed metal is such that it retains the lubricant.

The outside diameter of worn shafts, rods and pistons are usually prepared for metallizing by turning in a lathe using a sharp pointed tool and then flattening the ridges thus formed by using a Metco rotary shaft preparing tool. The ends of the turned area are then undercut with a single-point tool set at 30 to 45 deg and the area metallized immediately after preparation to eliminate the accumulation of dust, grease and rust that would obviously prevent a good bond between the parent and the sprayed metal.

The usual procedure for metallizing is used. The shafts are mounted between centers in a lathe with a dog on the part driving it from the chuck. The metallizing gun, mounted in the toolpost, is fed along the work at the average rate of 0.125 in. per revolution. The peripheral speed of the part being metallized ranges between 25 and 50 ft per min. In general, light coats of sprayed metal are obtained with the high peripheral and carriage speeds, while heavier coats are obtained with the lower speeds.

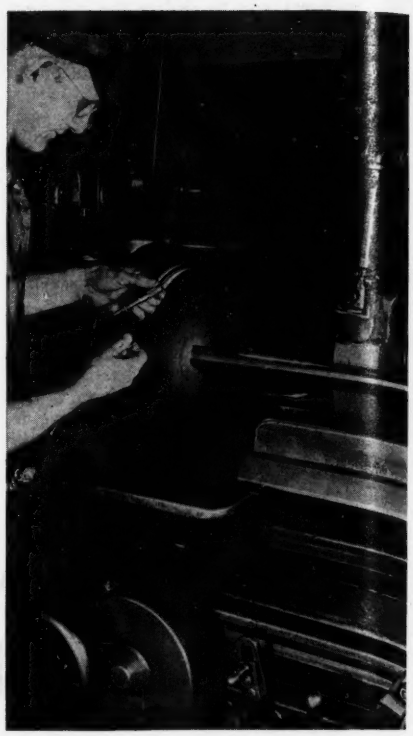


Fig. 4. An air-pump piston rod built up with the metal spraying process has just been ground to finish

Finishing Procedure

When parts have been metallized, they are finished by grinding or machining, with wet grinding being the most preferred practice. In general the following grinding data apply: Wheel speeds in surface feet per minute are 6000-6500; the work speed is 80-90 surface ft per min. Traverse speed of the wheel for roughing ranges from 35 to 50 in. per min.; and the finishing

g. 1. Worn rod being prepared by turning with a sharp pointed tool

Fig. 2. Second step. The thread-like ridges left by the sharp tool are flattened and knurled with a Metco rotary shaft preparing tool

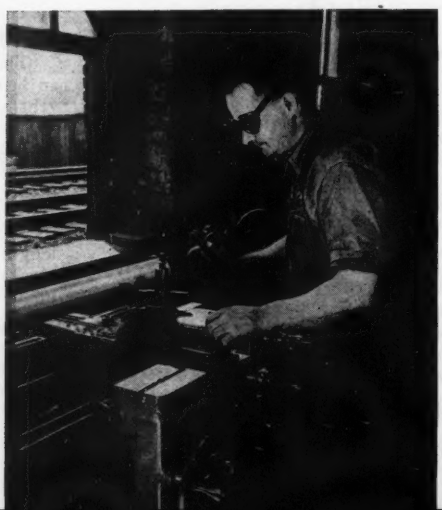
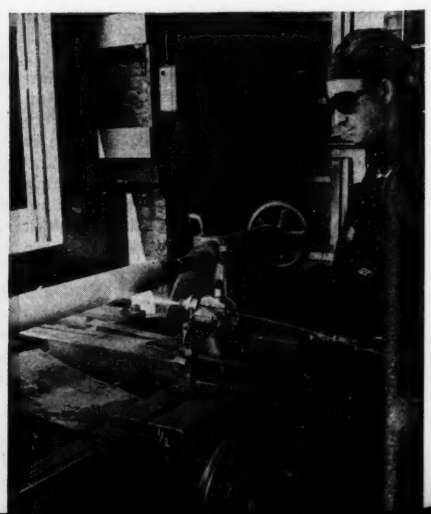


Fig. 3. Spraying the rod by means of the metallizing gun



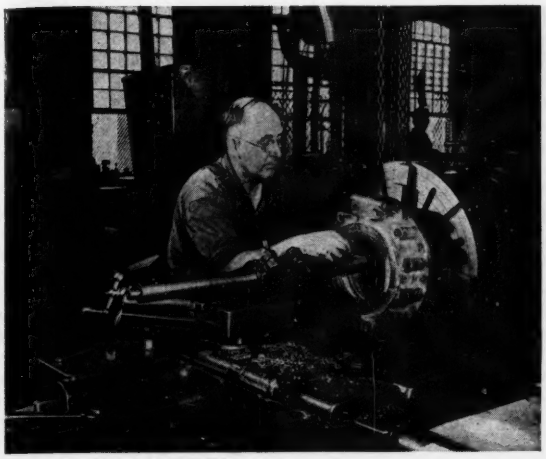


Fig. 5. (Above) Interior surface of spindle gland case for 2500-kw. turbine being prepared for metallizing by cutting a series of grooves

Fig. 6. (Right) After the gland casing had been built up the turbine was quickly restored to service

traverse speed of the wheel ranges from 8-16 in. per min. In every instance the in-feed of the wheel is very light, rarely exceeding 0.001 in.

During machining operations, the peripheral speed of the work using high-speed tools ranges from 50 to 100 fpm for steel and 100 to 200 fpm for softer metals. With tungsten-carbide tools these speeds can be increased about 100 per cent. Very light cuts are taken because of the structure of sprayed metal. The tool feed ranges from 0.003 to 0.007 in. per revolution.

Steam Turbine Rehabilitation

The skillful use of metallizing has enabled the Oliver Iron and Steel Corp. to keep its power plant equipment in its plant at Pittsburgh running with less time out than would have been the case without this method of treatment.

The heart of this busy factory, one of the largest plants in Pittsburgh, is a Westinghouse 2500-kw bleeder-type steam turbine. It supplies the energy for all lathes, drill presses and boring mills and other machine tools. An eroded spindle gland case in the turbine was causing leakage difficulties which threatened to result finally in complete failure. Under ordinary circumstances the gland case would have been replaced, but under present day conditions this might take 8 to 10 months. Repairs could not be made by welding since excessive heat would warp the case beyond reclamation.

With a Metco metallizing gun available, however, the spindle gland case was removed, grooved and grit blasted, metallized with Metcoloy No. 1 stainless steel, and then machine finished. All this was done without disturbing the basic characteristics of the case metal in any way in less than 16 hr! Cost was the least important factor in getting the turbine back into efficient operation, but the cost of a replacement—even if one had been available—would have been a hundred times that incurred in the metallizing process.

A complete metal spraying outfit is shown in Fig. 7. It consists of an air compressor and receiver, a compressed air drying unit, acetylene and oxygen storage cylinders, a control unit and finally the spray gun. A wire control unit is also a desirable feature as it insures straight wire feeding into the gun. Curved wire results in uneven atomization and spattering and this produced uneven surfaces.

Methods of Building Up Shafts

Shafts and other cylindrical surfaces can be built up by the metal spraying process by two methods. In one, the method usually employed, a number of passes are made across the work and the metal is deposited in a number of layers. In the other method the entire coating is applied in a single pass. For certain types of work, the one-pass method offers various advantages.

If the entire coat is applied in a single pass it will machine somewhat better than if applied by several passes. This is due to the absence of laminations, and to the fact that greater heat is built up at the point of application. Improvements in machineability are especially noticeable with the various bronzes. These metals are likely to show stratification lines if applied in several passes, especially if the traverse is not sufficiently rapid.

The one-pass method is especially useful where a large number of similar parts are to be built up, and also where the work is large enough so that local heat will not become excessive. For example, large shafts or rolls, 4 in. or more in diameter, usually may be handled quite satisfactorily in a single pass. And if the nature of the job is such that there is no warping trouble, much smaller work also may be handled by this method.

It should be remembered, however, that while one-pass coatings are somewhat denser and more readily machineable, the bond to the base material may be slightly weaker. This is due to the inevitable accumulation of dust and oxide in the pores of the prepared surface. Consequently, the one-pass method should not be used unless surface preparation is adequate. Blasting alone is not sufficient in the majority of cases. The method of grooving or threading, plus the use of the shaft preparing tool,

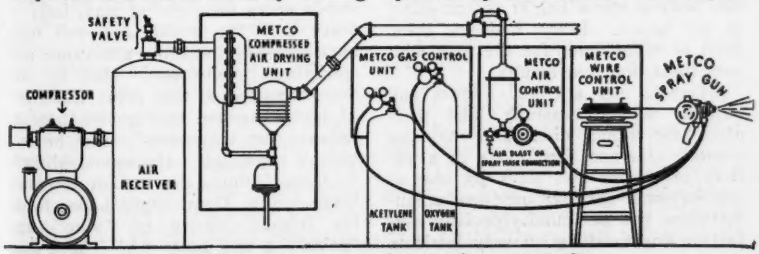


Fig. 7. Diagram of a complete metal spraying outfit

or grooving plus blasting with steel grit, should be employed. Since greater tensile stresses are created in coatings applied in a single pass, surface preparation must be thorough to reduce dangers of cracking.

Usual procedure when using this method is to first partly fill in the corners of the undercut section, and then mount the gun on the tool post—advancing the carriage periodically by hand, about ⅛ in. at a time. The work should be measured continuously by calipers at a point just behind the spray stream, since it is *absolutely essential* to apply enough for finishing in one pass with this method. If there are any low spots after the work has been traversed it is then impossible, in most cases, to go back and add metal. The surface probably will be oxidized and the pores filled with metal dust. And dull spots in the finish will almost surely result.

Also, it is essential in most cases that the job, once started, be completed without interruption. This is especially true of work which is small enough to heat up considerably, and on most all jobs where bronze is used. On large work, with stainless steel or monel, it may be possible to interrupt the work for a short period, such as for changing tanks or starting a new coil of wire, but generally it should be avoided.

Files and Filing

What do you know about filing and the different kinds of files available for different kinds of work? Here are a few pointers regarding different types of files and the various purposes they can be used for

By JOHN E. HYLER

FILES enter into maintenance in countless ways. Their application to the maintenance of various cutting tools is the largest. There are almost countless varieties of hand files that may be obtained for special purposes, and information on such may be obtained from file manufacturers.

Portable reciprocating files have been found very good for many types of maintenance work where it is necessary to do considerable filing in close quarters. One air-powered model, making anywhere from 500 to 5000 strokes per minute, is suitable for use on many forms of duty. It is of pistol type, and has a trigger valve. The reciprocating speed of this file is governed by the amount of air admitted through the trigger valve. Another very fine model of reciprocating file is electrically driven, and capable of a variety of work on maintenance jobs.

For welding cracks in machine frames, a coarse or bastard file of three-cornered type may be used to file a vee directly down into the crack, into which the weld metal will be deposited. The precautions necessary in pre-heating to avoid undue strain or distortion in the machine frame after the weld cools will not be dealt with here. Your shop welder will know about that. A portable grinding wheel dressed to a peaked face may be used for grinding a vee, but in most cases it will be found more convenient to use a file as mentioned.

If it happens that your shop is equipped with a rotary filing unit, it can be pressed into service for smoothing down the weld bead on machine frame and other maintenance welding jobs. Using a high-speed steel rotary file, you will find that a speed of about 200 surface feet per minute will be right on the tool for smoothing these welds. Final smoothing may be accomplished with any smooth-cut file, or, in cases where the job is an extra fussy one, you can use a file of the type used in autobody work, fitted into a holder made for the purpose.

Making a little further reference to the rotary filing machine, whether of flexible shaft type or of portable design, it is interesting to know that some firms make rotary rasps for such units, suited for working many different materials. For instance, special rotary rasps are available for rubber, leather, wood, ivory, fiber, and bone. So it will be seen that the rotary filing machine is a highly versatile unit for general odd cuts on varying materials in factory maintenance.

Hand and machine files should be kept as clean as possible. Regular use of a wire brush or file card will be very helpful. You will find that it pays to have a separate place for each file regularly used, as putting files together allows the delicate teeth to rub together. Especially, do not throw them together in a drawer. A good plan is to stand them up individually on the back of a workbench. If you have a bench used chiefly for filing, have the height of the filing vise jaws at elbow height as you stand at the bench. Filing benches, then, must be tailor made for the man who uses them, for best results.

Magneto files are well known, and nothing will successfully take their place for filing distributor or coil points. Oilstone files, made in a variety of shapes and sizes by one of our foremost abrasive products manufacturers, will be found especially useful for fine finishing on very intricate work, especially on tools and dies. If you do a great deal of hand filing, you will find that a good rubber file tip used on the forward end of the file will make for comfort, the same as the handle on the opposite end. You can make up such a file tip in an emergency, but they are commercially available.

In shops where there are many saws to be kept filed, whether those saws are used on maintenance work, or on other factory work, a filing machine for the purpose is a much better arrangement than depending on hand filing. There is a versatile type of saw filing machine much used, which will handle bandsaw blades, circular saw blades, or handsaws, thus keeping practically all saws that are capable of being filed in the pink of condition.

Commercial Types

1. The air-driven type of reciprocating file, pistol type with trigger valve, making from 500 to 5000 strokes per minute, is one made by Madison-Kipp Corp., Madison, Wis.

2. The electrically-driven model of reciprocating file is also ultra-portable, and is the product of Chicago Pneumatic Tool Co. of New York City.

3. Files of the type used in autobody work for smoothing, together with suitable holders for same, may be obtained from Heller Brothers Co., Newark, N. J.

4. A firm making all of the special-material rotary rasps mentioned, as well as a full line of rotary files and flexible shaft filing machines, is R. G. Haskins Co., Chicago, Ill.

5. Magneto files, and in fact a very complete line of the files chiefly used, are made by E. C. Atkins & Co., Indianapolis, Ind.

6. Oilstone files, as mentioned, are made by the Behr-Manning Corp., Troy, N. Y.

7. Rubber file tips may be obtained from J. L. Osgood Tool Co., Buffalo, N. Y.

8. The versatile filing machine mentioned for saw maintenance, handling bandsaw blades, circular saws, and handsaws, is one made by Foley Mfg. Co., Minneapolis, Minn.

Safety First

By Sam Williams

OLD SOL seemingly did little to temper the crisp air on that early December morning. Indeed, the day was made for youth, and Jerry, the new signalman, was well aware of it. Tool kit in one hand, voltmeter in the other, he strode down the right of way, fully at peace with the world, and well nigh bursting with youthful exuberance and confidence. Why not? Had he not been admitted to that great fraternity of horny handed and golden hearted fellows, the railroaders? Did he not have a swell job? He waved blithely to Dom Quinto, the section foreman. Some fellow, Dom. Open house to all his friends, plenty of "vino" and "pasta"—a true host. Ah! There goes Anton Zaniski. Anton answered Jerry's

greeting with his customary roar of good fellowship.

No. 12 thundered past, and Jerry thought of the interview with the Chief, that had resulted in his present employment. He had left the office, deeply impressed by the responsibility of his position. Why thousands of dollars worth of equipment and hundreds of lives would rest upon his ability as diagnostician and mechanic. Safety First, that was it.

Of course, in only two weeks, he could not be expected to know all the circuits. But he had the idea, and progressing rapidly had been detailed by the foreman, this fine morning, to check the track compensators, and look for some slight trouble in the signal tower.

He thought that he would do the comps first. The shifting engine went by, the conductor calling out his intention to "Work the Mill". That would be track three, thought Jerry. Well, the yard man had an hour to work the mill, then he would have to get off the main. No. 43 was due then, and woe to the man who plugged that hotshot!

He worked swiftly from place to place, and lifting the cover of the last instrument he found a broken wire. He eyed the signal bridge, a quarter mile down the track. Why, that was queer. Track three showed a high green, when it should have been red! The yard engine was working right around the bend, in an open block! Coming along at a good clip, was No. 43; her even staccato exhaust, thundering a challenge to the grade, spoke well for the skill of the valvesetter. Without hesitation, Jerry ran to the relay box, and pulled down the armature on track three home relay. The arm dropped to Stop! and No. 43's exhaust died away, accompanied by furious blasts from her whistle. What a place to stop a hundred car drag, on a grade and curve. . . .

Twenty-four hours later, Jerry stood before the Chief's desk, taking his medicine. Why didn't he know that the yard engine had proceeded to the next block, and entered a siding? Did he not know that that was customary? Why wasn't he familiar enough with the circuits to know that that broken wire affected track one, and not track three? And that it would have caused a Stop instead of a Clear indication? Mentally he writhed and squirmed, and prepared himself for the inevitable phrase, "You're fired".

To Jerry's amazement, the Chief arose, and taking him by the arm exclaimed, "Get back to work. We all make mistakes. But don't let me catch you making the mistake of *not* doing anything! The rule is Safety First." Laden with enough books and prints to furnish literally a study on the work, Jerry left the office. Dawning in his mind was the real meaning of the term, "executive ability". To know when a man is giving his best, and trying hard. That is executive ability.

Safe Welding of Oil Drums

Methods described by a committee of the Public Utilities of the National Safety Council for safely removing gasoline and oil vapor from drums and portable containers for the purpose of making welding repairs

By E. L. FITZGERALD

WELDING repairs in vessels which have contained gasoline or oil are sometimes required to be performed in the field. As a rule, adequate facilities in the form of cleaning solutions, live steam and combustible gas testing devices are not readily available to give complete assurance that the containers are sufficiently clear of explosive gases to permit the work being done safely.

The principal hazard is that of explosion. Petroleum vapors are three and one-half times heavier than air and will remain indefinitely in semi-enclosed spaces unless removed by the circulation of air or steam. A mixture of air containing 1.5 to 6 per cent gasoline vapor if ignited will explode. Under certain conditions a mixture containing as low as 0.2 per cent gasoline vapor may be dangerous.

This instruction will outline the various methods of cleaning drums (not in excess of 50-gal. capacity) for welding which are to be followed, depending upon the facilities available.

METHOD I. Removing vapors with cleaning solution, steam and testing with a combustible gas indicator—recognized standard method:

(a) See that all sources of ignition such as open flames and unguarded electric lights have been removed from the vicinity of the container.

(b) Remove the bung with a suitable wrench, being careful not to cause a spark. Do not use a hammer and chisel.

(c) Wash out the vessel with a solution of caustic soda, soda ash (washing soda), trisodium phosphate, etc., rotating the vessel mechanically for a period of 5 or 10 min. and drain thoroughly.

(d) Flush with live steam for a period of 1 hr., tilting the drum so that the contents will drain out.

(e) Inspect the inside to see that it is clean. If interior contains scale, agitate with a chain, tap exterior with mallet and repeat the washing.

(f) Test the vapor content with an approved combustible gas indicator.

(g) Perform the work within a 30 min. period after steaming or while the vessel is still hot. See that bung is removed.

METHOD II. Removing vapors with steam only:

(a) Same as in I.

(b) Same as in I.

(c) Drain the vessel and flush several times with hot water.

(d) Pass steam into the tank for a period of 3 hr. for gasoline containers, and 1 hr. for oil containers. Tilt the vessel so that the contents will drain out during the operation.

(e) Do the repairing within a 30-min. period following steaming operations or while the vessel is still hot. See that bung is removed.

METHOD III. Removing vapors without cleaning solution, live steam or without testing with a combustible gas indicator:

(a) Same as in I.

(b) Same as in I.

(c) Flush the vessel several times with hot water and thoroughly drain the contents.

(d) Place the vessel over a fireplace and fill to about seven-eighths full with water.

(e) Light the fire and *boil for 3 hr.*

(f) Do the repairing within a 30 min. period after steaming. When this is not possible, repeat the boiling. See that bung is removed.

CAUTION.

(1) When caustic soda is used, care must be taken to guard against alkaline burns to person or clothing.

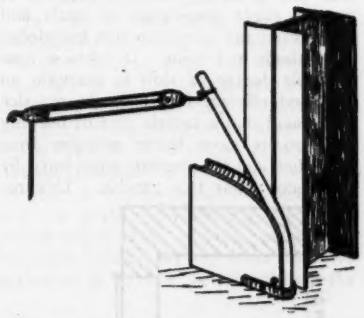
(2) A metal steam line, if used, must be bonded to the vessel to drain off static accumulation.

(3) When repairs are to be made in vessels containing more than one compartment, all compartments must be cleaned by the same method and as thoroughly as the one in which repairs are to be made.

Easy Pipe Bending

SIZES of brass and copper pipes commonly employed and iron pipes 1 in. and less in diameter may be bent cold in the following manner, care being taken when doing so to have the seam on the inner curve:

With a brace and bit bore a hole about ½ in. larger in diameter than the pipe to be bent, in a solid well-supported soft pine timber. Insert the pipe to the point at which the bend is desired and make the bend by pulling slowly to one side, moving the pipe in and out a little after each pull.



Small pipe can be bent as desired over a simple form

If any considerable bend is required, a form should be made having the curvature to which it is desired to bend the pipe, and while one end of it is held fast, the pipe should be bent around this form. If the curvature is sharp, fill the pipe with perfectly dry sand and heat it to a red heat before bending.

Hand Firing Practice

It may seem strange to many to see this article on hand firing appear even in this section of Power Plant Engineering, which is devoted to the interests of the practical engineer. Hand firing as pointed out below belongs to a bygone era and it has little place in the highly mechanical world of today. True, there are many small hand-fired plants still in operation but that does not justify a great amount of attention to the general subject of hand firing in normal times. These, however, are not normal times. Power plant equipment is hard to get; as a consequence many plants are impressing into service old units, boilers and engines which may not have been in use for years. Many of these old boilers were hand fired and since new stokers cannot easily be had, hand firing becomes necessary. In the meantime hand firing has become somewhat of a lost art. Operators who have been accustomed to operating stokers or pulverized coal equipment are not necessarily skilled in the use of the scoop and slice bar and they are at a loss to know what to do when they are confronted with the problem of hand firing. During the past months we have received many requests for information on methods of hand firing and it is to satisfy this demand that we present this article. The old timers who cut their teeth on the handle of slice bars and scoops will find little in it that they do not know but the younger men to whom the term "firing" means the adjustment of some push buttons may find in it a few pointers which may help them in putting some of the old boilers back to work

HAND FIRING is part of an era which, fortunately, belongs to the past. At best it is hard, hot work and it has little place in the automatic world of today. Mechanical stokers, pulverized coal firing and fuel oil firing have displaced hand firing in all but the smallest and most obsolete plants.

Under the conditions existing at the present time, however, when many old and normally obsolete boilers have been pressed into service and when stoker repair parts are not easily available a certain amount of hand firing has become necessary.

Hand firing, despite its drudgery, is somewhat of an art and unless it is done properly, the results will be quite disappointing. Hand firing requires more than just a strong back; it requires at least a slight knowledge of coals and combustion and a considerable knowledge of methods and tools. It takes a considerable degree of skill to maintain an even and efficient fuel bed. In practice it is found that a certain rate of burning coal usually gives better ecenomy than any other and the fireman must learn by experience what this rate is. This requires knowledge of his grates, his draft and other things.

The amount of fuel that can be burned per square foot of grate depends on the draft, the fuel and the air space in the grate. Engineers are not at all agreed as to the advisable size of the air spaces in furnace grates. The grate is intended to support the fuel and to pass the air required for combustion. It would seem that the more air a grate can supply while supporting the fuel in a satisfactory way, the more efficient the grate would be. The air spaces for bituminous coal should not be less than ¼ in. nor more than ¾ in. wide. A straight grate with 5/8-in. openings and ¾-in. bars provides a little less than 45 per cent free air space. This amount of air space is desirable for bituminous coal if it can be secured while meeting other conditions for a grate. For steam sizes of anthracite, practice usually calls for air openings from 3/16 in. to 5/16 in. wide, giving air space of from 10 to 25 per cent of the grate area.

It makes little difference whether the grates are flat or inclined, except in convenience of firing. If a grate is long, sufficient inclination to give the fuel a slight tendency to roll towards the back will assist in firing and have no injurious effect. An inch to an inch-and-a-half drop per foot towards the rear is considered good practice.

Whatever the grate and whatever the grate surface, it is essential to keep the grates properly covered with fuel, otherwise an excess of air will enter the furnace through the grate and lower the efficiency. Too large a grate area is quite as injurious to the efficiency of the boiler plant as too small a grate area. With a grate too small, the fuel bed is carried thicker than is desirable and it is impossible to get enough air through the bed to produce proper combustion. With too large a grate area, the air supply through the fuel bed is excessive, affecting not only the combustion of the fuel but also the transmission of heat to the boiler.

Twenty to 30 lb of coal per square foot of grate per hour is good for bituminous coals and provision should be made for driving the boiler to at least a horsepower for each 5 sq ft of water heating surface. This should be accomplished with a draft of not over 0.5 in. of water, as a higher rate of draft tends to pull holes in the fire. Three-tenths of an inch draft is a good average figure and with this draft the following figures may be taken as rough approximations only, for hand fired grates.

COAL PER SQUARE FOOT OF GRATE PER HOUR

No. 3 "Buckwheat"—anthracite	8 to 8.5
No. 1 "Buckwheat"—anthracite	10 to 12
Pea — anthracite	14 to 16
Md., Va., W. Va., and Pa. semi-bituminous	20 to 24
Ill., Ind., and Kan. bituminous	18 to 26
Ala., Ky., Pa., and Tenn. bituminous	19 to 28

Standard Practice For Hand Firing

The following procedure in firing is that recommended by the Bureau of Mines.

The fireman must take a proper position so that he can see the thin spots and can throw the coal onto them with the least effort. He should stand 4½ to 5 ft in front of the furnace, and 12 to 18 in. to the left of the center line of the door. He should then be about 2 ft from the coal, which is 6 or 7 ft, from the furnace front and preferably on a cart.

The scoop should travel in a nearly straight line. At the end of the throw, the scoop should suddenly be stopped by laying it on the bottom edge of the door

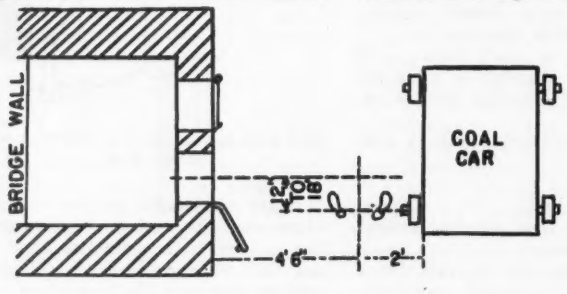


Fig. 1. A proper position for firing the furnace

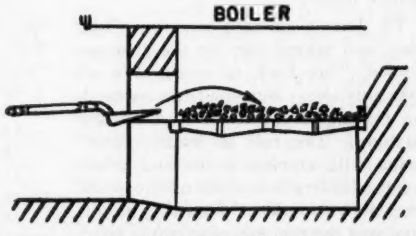


Fig. 2. The end of the throw. The scoop is stopped by laying it on the lower edge of the fire door frame, and the coal, following the course of the arrow, slides off the scoop and falls on a thin spot in the fuel bed

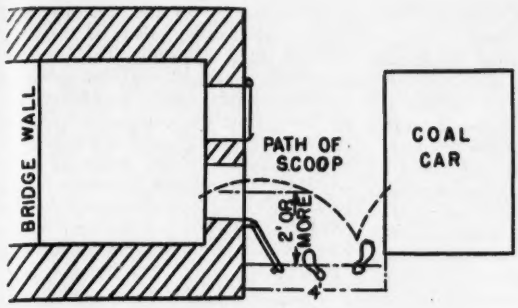


Fig. 3. Improper position for firing
The fireman stands too near the furnace and too far to one side. He cannot see the surface of the fuel bed and throws the coal in by guess; some of it falls off the scoop before the latter reaches the firing door. The coal car is too near the furnace. The dotted lines show the path of the scoop

frame. The coal then flies off and is scattered over the proper spot. By thus stopping the scoop, the fireman saves effort, and locates the coal better. If he pushes the scoop way into the furnace, he has to jerk it back to get the coal off.

Hand firing is hard work, and requires considerable judgment and skill. There should be sufficient firing space to handle the shovel and tools.

If the coal is closer than 6 or 7 ft the fireman is crowded and will stand away to one side of the door to avoid the intense heat. He cannot see the fire, and throws the coal in by guess. His scoop travels in the arc of a circle, scattering the coal on the floor and dumping it in a heap directly inside the door. This results in an uneven fire, low efficiency, and requires raking of the coal onto the back part of the fire.

A smooth firing floor should be provided or a smooth bottom to the coal cart so that the shovel does not hit bumps or rivets. Such items delay the firing operation, keeping the door open longer than necessary and admitting excess air. According to Joseph Hays the eminent combustion engineer who died recently, about one per cent of the coal is lost in the average plant due to waste in handling at the plant. Coal is thrown on the floor and ground to dust by feet and wheels, and mixed with ash.

Light and Frequent Firing is Desirable

Coal should be burned rapidly and at high temperatures to secure the best available economy. Fire small quantities of coal at short intervals so that thin places do not burn through and admit large excess of air. With a draft of 1 in. in the uptake, a deposit of 2 to 2½ lb of coal per square foot of grate is a good average. Thus, on a grate 6 by 8 ft, there will be deposited about 100 to 125 lb of coal, or about 6 to 9 shovelfuls. This, in other words, represents the quantity of coal for one firing. The intervals should be about 5 min. For a higher draft, the periods could be 3 min., and with a weaker draft they could be lengthened to 8 min, but under ordinary circumstances they should never be more than 10 min. This method of firing makes the coal supply more nearly proportional to the air supply which in most plants is nearly constant.

Light and frequent firing is desirable for the following reasons: When fresh coal is fired, the volatile matter is immediately distilled. The process is nearly completed in 2 to 5 min, therefore, immediately after firing large quantities of air should be admitted over the fire. After 2 to 5 min it should be cut down. Such regulation is practically impossible. As the air supply is practically constant, immediately after firing it becomes insufficient and incomplete combustion results. After most of the volatile matter has been driven off, the air is in excess. The two losses are much less when small amounts are fired at frequent intervals. Automatic air control devices can be purchased, but even with them frequent and light firing is best. Frequent firing alleviates the tendency to form a crust on top of the fuel bed.

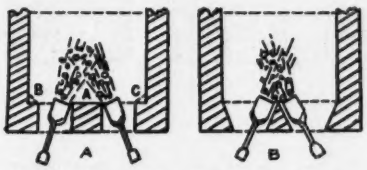


Fig. 4. Diagrams showing how the formation of thin spots near the furnace door frame can be avoided

A hot fire should be maintained at all times. A man can tell by the sight if the fire is becoming cool, even without instruments, and this is the surest standard to follow in hand fired plants.

In looking for holes and thin places in the fire, be particular to look in the corners at the front of the furnace, and between the firing doors. Figure 4a shows the common form of furnace front construction,— the furnace door openings being relatively narrow, the pier between them relatively wide. In many plants having this type of construction, excess air will be found entering to a damaging amount through the triangular space upon the grates at A and to some extent through the corner pockets at B and C. Piers as wide as 36 in. are often found between the fire doors, making it utterly impossible for the fireman to throw coal upon the triangular space at the rear of the pier. The fireman cannot throw a curve when he is shoveling coal. The diagram, Fig. 4b, shows how this defect may be easily remedied. Fuel economy depends upon little things and many of them. The diagram, Fig. 4b, is intended merely to illustrate the idea. It would be impracticable to build the center pier with sharp points as shown.

Firing doors are often opened too frequently while coal is not being fired in order to inspect the fire, and excess air is thus admitted. A 1½-in. mica-covered peep hole in the door will avoid this. In one plant the percentage of CO_2 was increased 1½ per cent by the installation of such a peep hole.

A skillful fireman can estimate at a glance the amount of coal required for a given spot. Almost unconsciously he picks the right amount and selects the right mixture of fine and coarse coal. If the coal is burned way down he selects coarse coal to avoid its sifting through the grate. This also permits of the building up of the level of the spot more quickly as the coal does not tend to fuse so much as slack. Thin and thick spots will occur, even with the most careful firing. In places where the air flows freely, the coal burns faster, forming a thin spot. The cause of variation in air flow may be due to the difference in the size of the coal, in the accumulation of clinker or in the fusing of the coal into a hard crust. Before firing fresh coal the fireman should note the thin places. They have bright, hot flames, while the high spots have smoky flames or none at all. If the holes are burned through, some authorities recommend covering them with incandescent coals before firing. Place the coal on the thin spots in thin layers. If deep hollows are filled at once, fresh coal may fuse and choke off the air, forming a new high spot. If high spots are missed for one or two firings, they will burn down to normal. If the high spot is due to clinker, the clinker must be removed.

Methods of Hand Firing

In general hand firing methods can be classified according to three methods. The first method is that of firing large quantities of coal at long intervals. This method is mentioned only because it is absolutely wrong, yet used by many indifferent firemen. The second or alternate method shown in Fig. 5 is that of spreading four or five scoops of coal over one-half the grate, then waiting one firing period before firing an equal amount by the same method on the other half. A variation is to fire one-fourth of the

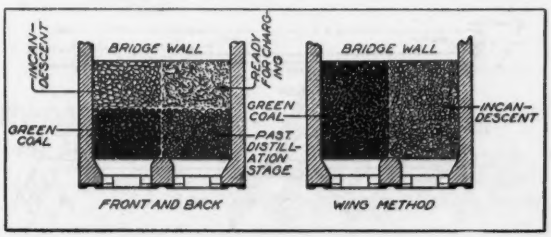


Fig. 5. The alternate method of firing

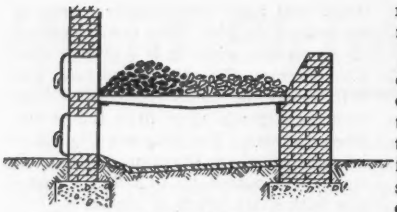


Fig. 6. The coking method of hand firing

grate at a time—left front, right rear, left rear, right front. With high volatile coal, it is necessary to open the door slightly for a few minutes after firing in order to furnish sufficient air for smokeless combustion. Probably this method is the one most generally used because the fire doors are kept open for but a short period and it is easy for the fireman to spot clinkers quickly. The fuel bed is not disturbed, which is an important item with clinkering coal.

In the third or coking method of firing, Fig. 6, the coked coal is cleared from the front third of the grate by pushing it back evenly over the back two-thirds, being sure to fill all the holes. A quantity of fresh coal, 8 to 12 in. thick is then fired on the front end. There should be no fire on the dead plate.

Gas is distilled from the fresh charge and is consumed as it passes over the incandescent coke bed. With this method it is difficult to keep holes from burning through the coke bed.

The spreading or alternate method of firing gives higher efficiency, higher CO_2, lower temperature of exit gases, and generates steam more uniformly than does the coking method, due to more uniformity in furnace temperature. About the same amount of slicing and raking is required in either the coking or spreading method, excluding, of course, the leveling required in the coking method.

According to the Bureau of Mines the coking method of firing produces less clinker, since the leveling of the fire at the firing period shakes more ash through the grate, and lower CO_2 due to longer firing period. The analysis of the ash shows no difference in the amount of combustible consumed for the two methods of firing. The coking method is not feasible with fluctuating loads since holes that cannot be seen develop in the rear of the fuel bed. The coking method is a good smoke preventer but experience is required before it can be used without loss of efficiency.

Cleaning Fires

A few words regarding cleaning a fire. There are two methods of cleaning a fire. 1. The unburned coal may be pushed or "winged over" from one side of the furnace to the other. The ash and clinkers may then be raked out and the burning fuel winged back upon the clean grates, whereupon the other side may be cleaned in the same manner. 2. The unburned coal may be pushed back against the bridge wall, and the clinkers and refuse then raked out at the front, whereupon the burning coal may then be raked back and distributed over the grates. One side of the furnace is cleaned and the fuel distributed for a new fire before the other side is cleaned. This method is more expeditious than the first mentioned but it is not as thorough for the reason that the ash and clinker under the fuel next to the bridge wall cannot be removed and may fuse in a short time into a very troublesome clinker. When cleaning must be done in a limited time this method may be used. In Fig. 7 is shown a diagram of the first mentioned method of cleaning, that is, the "side method" as it is called. The slice bar and hoe are used to work the unburned coal over, after which the clinkers are cut loose from the grates and from the side wall and bridge wall and pulled out with the hoe. When the grates are properly cleaned on one side the fuel is moved back and the operation repeated for the other side, after which the fuel is distributed over the grate and a fresh fire built up.

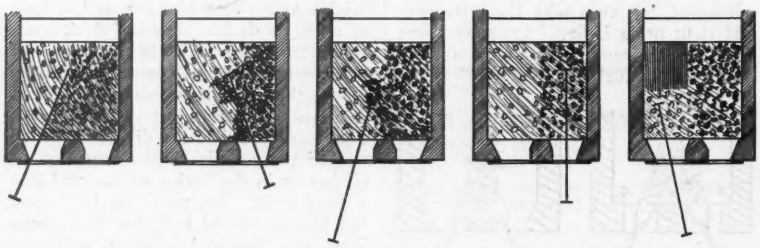


Fig. 7. The side method of cleaning. The slice bar and hoe are used to work the unburned coal over, after which the clinkers are cut loose from the grates and from the side walls and pulled out with the hoe

Cleaning of the fires should be done when it will interfere least with plant routine. It should be done when the load is light insofar as possible so that peak loads can be met with clean fires. Large clinkers should be pulled out as they are found, provided that this can be done without making matters worse. The hook or rake and slice bar can be used for this purpose, the latter to cut the clinker loose from the grates. Large and pasty clinkers can be handled in this way but when there are a large number of small clinkers the stirring of the fire necessary to find them will do more harm than good.

Firemen should learn to use the proper tools for the proper purpose. The slice bar is a much misused tool. It should be used on a live fire, only for slicing the clinker loose from the grates. It should not be used as a pry to lift the clinker clear of the grates. This mixes ashes and fuel, and the relief of a better air supply through the grates is short lived. Some firemen have a habit of pulling clinkers out of the furnace without scraping and pushing the burning coal against the bridge wall or to one side. This is not a good method of cleaning a fire. They run a slice bar under the clinker to lift it to the surface of the fuel bed. Then they take a hoe and pull the large pieces out. The small pieces are not easily detected and are left in the fire. These fuse in a few minutes, due to the high temperature near the surface of the fuel bed, and then run into the grates. Thus masses of clinker are formed, which are usually worse than those previously removed.

Firing, like any other thing involving a number of variables, requires judgment and the application of common sense. A knowledge of the simple elements of combustion helps as does an understanding of the characteristics of the coals he has to handle but beyond that much of his skill will rest in his ability to analyze furnace conditions as they appear. Knowledge comes with experience.

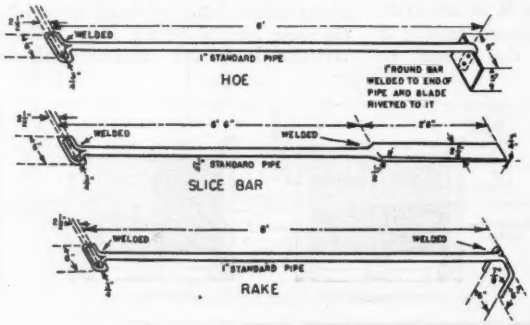


Fig. 8. The three most important fireman's tools

CORRECTION—OIL TO COAL CONVERSION CHART

We regret very much a typographical error in the Oil to Coal Conversion Chart appearing on Page 100 of the July issue. On this chart the heat value of oil is given as 186,000 Btu per lb. Obviously, this figure should have read 18,600 Btu per lb.

the medicine man was a humbug

Photo in Nalco Laboratories

THE medicine show was a lucrative racket but science and education have run it pretty well into the ground.

There is no cure-all for human ills and there is no one-shot remedy for water treatment problems. Nalco maintains the world's finest water treatment laboratories for developing the right treatment for each and every problem. From these laboratories have come many original developments which benefit Nalco customers. For permanent and unvarying results, call the Nalco man today. You'll be glad you did.

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The Complete Water Treating Service

LETTERS AND COMMENTS

On Compressed Air in Pumps and the Use of Old Pumps

IN AN ARTICLE[1] published some time ago, Harold S. Sykes described the use of compressed air in a duplex steam pump for core sucking. This article was of considerable interest to me. As a practical expedient, this method of operating a pump cannot be criticised but it is probably an extremely costly way to move water. Under the best of conditions, compressed air is an expensive form of motive power. When used in a duplex steam pump, it is bound to be very costly. Mr. Sykes should bear in mind that all the energy put into the air in the form of heat is a total loss before it gets to the pump. Then, the pump itself, described as a "small duplex pump" probably had a "steam rate" of anywhere from 125 to 200 lb of steam per hr, compared to possibly 6 to 7 lb of steam per hp-hr in the power plant from which he purchases electric energy. If his pump is old, it may use still more operating fluid than indicated above.

Without accurate data on pressures, power costs, etc. it would not be possible to work out the exact excess cost of his air power over the cost of doing the same job with a positive pump operated by a small electric motor, but this method will undoubtedly use 8 to 10 times as many kw-hr per day. (I'm assuming that the air compressor is electrically driven.)

No one can make any excuse for the use of a duplex steam pump for boiler feeding unless all the exhaust steam is required for feedwater heating, in which case it acts as a pressure reducing valve, albeit an extremely inefficient converter of heat energy into mechanical work. As noted above, unless the air is used without cooling, there is a still further loss of energy in the use of compressed air.

We may all have to raid our junk piles during the present emergency and do things uneconomically. However, we should do it with our eyes open and with a full knowledge of the results. After all, in cases such as this, I doubt very much whether saving a few pounds of metal needed to replace or repair the old pump at the cost of the continuous use of power uneconomically is exactly a gain for the war effort.

I admit to being a decided "crank" on the subject of "getting the job done PERIOD" vs. "getting the job done economically." Raids on the idle equipment in the junk pile or surplus warehouse more often than not seem to satisfy the first statement only. I have often envied engineers in organizations which make a practice of junking or selling any unused equipment, thus removing any temptation to install it at a later date on a job for which it is not exactly suitable. (During the present emergency, it is nice to know there are a few spare centrifugal pumps, motors, and the like around, I'll admit.)

I would like to suggest a series of articles for your section on the use and misuse of centrifugal pumps. It has been my observation that in far too many industrial plants much power is wasted from the indiscriminate application of centrifugal pumps on the basis of availability or low first cost rather than on the basis of efficient utilization of power.

It is not at all unusual to find instances of the wrong pump being used on the right job with the result that the unit is working at 25 per cent efficiency or so (and in many cases warming up the circulating medium where this is objectionable , as in cooling water, brine, etc.) The right pump would do the work at 75-85 per cent efficiency, thus using only 30-33-1/3 per cent as much power. Nor is it unusual to find plants in which the average efficiency of all pumping units in the plant will be in the neighborhood of 40-45 per cent, indicating that approximately one-half of the total power used on pumps is being wasted.

Probably such a series would be wasted on the "rule-of-thumb" old-timer who doesn't consider "paper work" or "design" a part of the duties of the "practical" engineer. However, if only a few of our younger men could be convinced that the 4-in. "farmer" pump back on the junkpile belongs in the scrap melting furnace instead of on the condensing water system of a plant running 24 hr a day, where it may easily use up enough extra power every 3 to 6 months to cover the entire cost of the proper high efficiency job, such a series would be well worth while.

No, I'm not in the pump business in any capacity. I just happen to have seen so much misapplication of centrifugal equipment and so many engineers whose knowledge of hydraulics was nearly zero that I'd like to see someone make a stab at trying to put over some of the fundamentals in non-mathematical language.

Los Angeles, Calif. P. S. CARNES.

[1] December, 1942. Page 88.

Technical Knowledge

DURING my 50 yr of engineering afloat and ashore, I have had many hazardous, illuminating and humorous experiences with the human and mechanical elements encountered hither and yon. I have written a million words about these some of which fell on stony editorial grounds and others brought a fair crop of folding money.

None were high brow. They all lacked the charts, formulas, diagrams, and technical finesse of the college man, and my English and grammar were missing on all cylinders, but they did take you from here to there and left you with something to think about. All of which brings us to the high-brow controversy over the 65 degree heat question.

Which is reminiscent of the Philosopher and the boatman. The old chap was rowing the man of science across a wide and deep river, when the professor asked, "My friend, have you studied Astronomy?" The old man shook his head and rowed on. "Too bad," the wise one said, "one-fourth of your life has been lost. But perhaps you've read up on Philosophy?" Again the old guy shook his head and rowed harder. "My, My," the professor groaned. "Another fourth of your life has been lost. Surely you have some knowledge of Geometry and Physics?"

"Nope," the old man replied, taking off his coat. "Have you learned to swim? If not all your life is lost for the boat has sprung a leak and we are sinking."

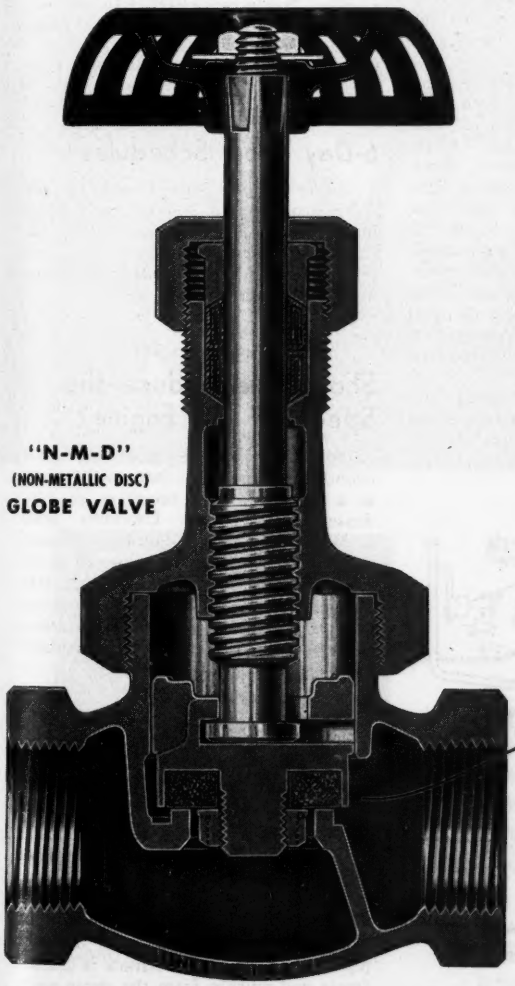
The application of slide rule formulas in fuel saving in heating all buildings is like the patent medicines which cure all ills. I recall a fuel test made on a battery of three 400 hp, and three 250 hp water tube boilers made by some experts in a railroad power plant recently.

Rigging up a tank to measure the feedwater on one of the 250 hp boilers, they spent 24 hr measuring water, weighing coal and ashes, consulting charts, slide rules, etc., and submitted their report to the Super, as a test of what the plant was doing. Any practical man would know that this could not be a fair test of the performance of all the boilers, but it went over big with the Super, and it took a long time to convince him that efficiency of boiler, furnace, and grates, with the experience and attention of the man in charge, had a whale of a lot to do with the overall fuel efficiency. Technical knowledge is

Simplicity of Design Means Easier Maintenance

Plus Value

for the Maintenance Man...



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The scarcity of new valves these days places a premium on the lasting qualities and repairability of those you now have in service.

Valves with a minimum of parts...that are easily accessible for cleaning and repairs...that are made to such true tolerances that parts are interchangeable *in fact*...such valves give a plus value in time-saving and low-cost servicing.

Maintenance men who work with Lunkenheimer valves are receiving continual proof that simplicity of design means easier maintenance ... they are getting better service longer, and doing a better job faster.

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Disc can be renewed in a jiffy. Simply unscrew locknut from disc holder, remove old disc and insert new one—reassemble and the valve is ready for use. Or better still, keep on hand some spare disc holders complete with discs—slip a disc holder and a new disc on the stem and remove the old disc from the holder when you have time.

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BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS. ASK FOR CATALOG 78

highly useful but common sense combined with experience, and interest in the job, is just as important.

As King Agrippa said to Paul, "Much learning hath made thee mad." Like some drugs, technical knowledge is useful when combined with practical experience, but highly explosive without.

"With all thy getting, get understanding."

Wilkes-Barre, Pa. THOMAS M. STREET

Questions And Answers

Question No. 233

Why Does the Flow Meter Lag?

To MEASURE steam flow to two digesters in our paper mill, we have two flow meters installed as shown in the diagram. The digester steam piping, carrying steam at 125 psi, comes up through the charging floor as shown. The meters are mounted side by side on a wall about 20 ft across the building from the wall where the two sections of piping XX and YY are located.

Both meters are installed in every respect according to their manufacturer's recommendations, have been inspected and approved by their representatives. However, No. 2 steam flow meter invariably lags for 15 to 30 min, when the steam is shut off, before reaching zero from about 20 per cent of chart. On the other hand, No. 1 meter works perfectly. Maximum differential of No. 2 meter is 53 in. of water, at which it records 15,000 lb of steam an hour.

What is the cause of this lag and how can it be eliminated? It is appreciated that this is a small inaccuracy that affects integration and can be readily overcome by use of the planimeter. But if you consider the use of the flow meters for digester control, that is another story entirely.

The charging floor is the highest point in the mill and, although pipe sections XX and YY are similar, the layout is such that Dimension "A" is different for the two meters. When I first read the very fine series, The Why, When, Where, What and How of Flow Meter Installation, by W. C. Bennett, (POWER PLANT ENGINEERING, Oct., Nov., Dec. 1942, Jan., Feb. 1943) I thought possibly the answer was in the differences of Dimension "A", discussed in the February issue and illustrated on page 110. I thought false differentials might cause the trouble.

However, Mr. Bennett shows that Dimension "A" is never involved if the steam pressure is above 25 psi. It was suggested that the meters themselves were out of adjustment but they have been checked by the manufacturer as well as myself and I'm sure they're all right. Furthermore, to satisfy everybody and prove the trouble is not in the meters I interchanged the meter connecting piping for a week but the trouble continued just the same.

One solution suggested is to rearrange the piping as shown in dotted lines, bringing the orifices well above the meters. This is a standard layout in most digester rooms. However, it would be quite costly in this case. I also considered running 1-in. leads from the take-off each side of the orifice to bring the reservoirs above the meter in the case of No. 2. Construction details prevent this without using a segmental orifice. Even so, it would be awkward and the results problematical.

Any suggestions readers may have will be appreciated. It would also be interesting to calculate the probable error at 50 or 75 per cent chart if this should be transmitted in its corresponding effect at these ranges.

Quebec, Can. F. J. N.

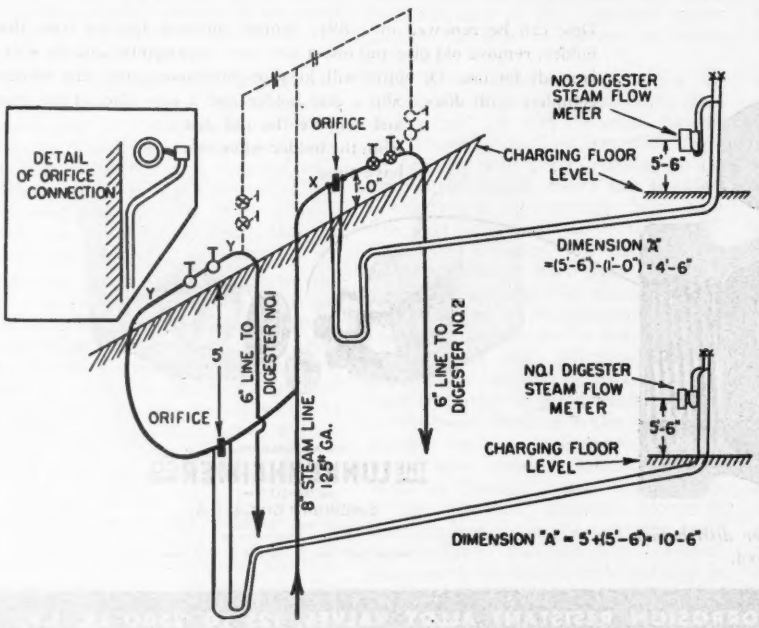


Diagram by F. J. N. showing layout of digester piping and flow meter connections. Dotted lines show suggested piping re-arrangement

Answer No. 231

6-Day Work Schedules

Editor's Note—Many thanks to the Q&A readers who sent in work schedules for a 6-day week in response to R. J. K's request in the July issue. Several of these schedules will be published in the near future.

Answer No. 202

Should He Reduce the Speed of His Engine?

So MANY readers have had ideas about this question that with space at a premium, it is necessary to condense them. In the December issue L. M. J. vL. asked the question: Should he reduce the speed of his 50-yr-old 13x19-in., 100-rpm slide valve engine, taking steam at 125 psi gage and exhausting at 5 psi gage, in order to reduce steam consumption? The engine drives laundry equipment through a lineshaft.

Overhaul Engine and Valves, Check Exhaust Line

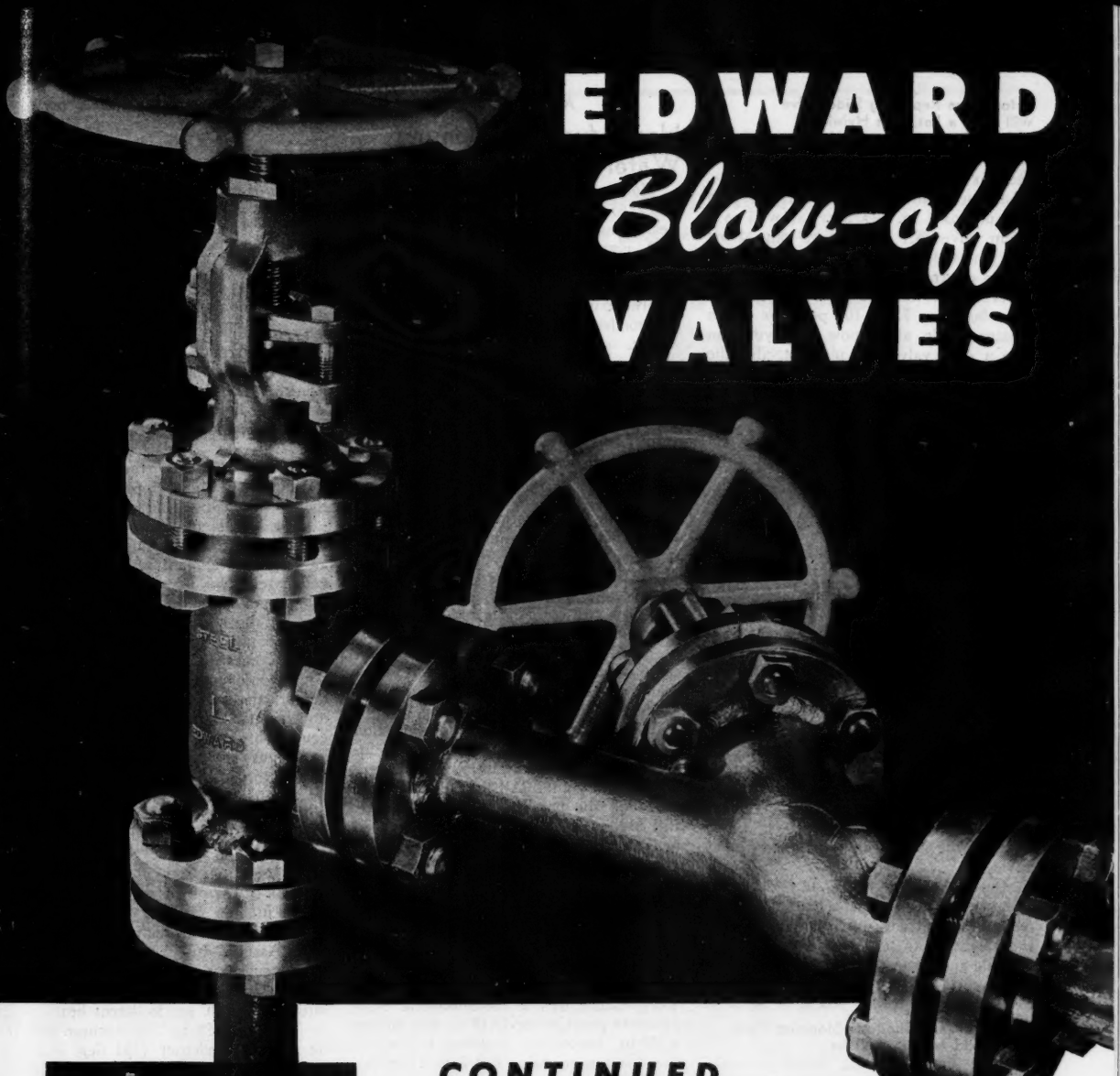
THE FIRST thing to look for is excessive steam consumption due to worn cylinder, piston and piston rings. . . . The valve setting should also be checked to determine if it is correct.

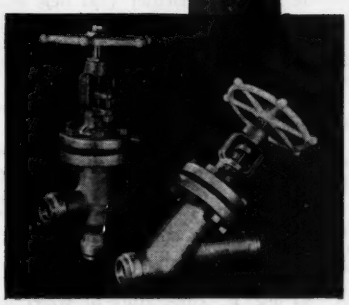
The exhaust line should be examined for water pockets, unnecessary elbows, as well as correct diameter. If the exhaust line is unusually long, it may be necessary to substitute a larger diameter pipe. . . . Unless the condensate is drained freely and quickly from the steam-using equipment, it might, under some hookups, create excessive back pressure.

Attention should be given to the above before doing anything about reducing engine speed.

Atlanta, Ga. C. T. BAKER

EDWARD *Blow-off* VALVES





Built with both socket welding ends (above) or flanged ends (below) Edward blow-off valves have a minimum of internal parts. Hence less clogging, erosion, adjustment or replacement.

CONTINUED TIGHT CLOSURE

Nothing is more important in a blow-off valve than tight closure over long periods of operation.

That's why Edward blow-off valves are of globe type seating design. That's why, too, the materials used in their manufacture have been carefully selected so that the coefficients of expansion are such that a valve closed tight under high boiler temperature will still be tight when cool.

For any power plant, marine, oil field boiler or process piping service from 150 to 1500 lb sp service, specify Edward. The choice of straightway or angle design makes possible a wide variety of installation combinations to meet space limitations. The Edward Valve & Mfg. Co., Inc., 220 West 144th Street, East Chicago, Indiana.

EDWARD *Steel* **VALVES**

Piston Valve Replacing Slide Valve Will Help a Lot, Says Heiwig

AS WE ALL KNOW, these old timers were built to pull or work like hell—and likewise to hell with the water rate. I have seen some of these old gals with as much as 1 in. clearance, as well as a steam valve port 12 to 14 in. long. How can you remove shims to take up this excess clearance?

We know that most of these engines were built for 75 to 100 psi gage steam pressure. We also know that you can take a slide valve and plane it, also the seat, scrape it into a perfect seat, start the engine up and the valve will warp in spite of everything. How are you going to keep a low water rate with that kind of valve?

What did the railroads of our country do? They went to piston valves and gun metal liners for cylinders and valve chambers.

It has not been so long ago that I saw an old Buckeye cross-compound with Meyers riding cutoff changed from the old-style D or flat valve to a Baker piston valve and the steam consumption was reduced by 40 per cent. This old engine was bought in 1881 and she is still turning over every day, doing 600 Ihp. The low pressure valve in this old engine weighed 1750 lb. Try to keep it from warping! I also saw a Baker valve placed in a slide-valve engine of very early date, which also showed a reduced steam consumption; this engine is of a very good make with a good shaft governor.

As to the steam engine indicator, good advice.

I would say to L. M. J. vL.: Have a Baker valve installed, rebore the cylinder and install a piston that will reduce the clearance to as small an amount as possible and I can assure him of pleasing results.

Seymour, Ind. WM. F. HEIWIG

Carl Bachmann Suggests Stopping Heat Losses and Makes an Offer

How about lowering initial pressure to 100 psi.? If I remember correctly, operating pressure of ironer shall not be in excess of 100 psi. Observe and check engine back pressure carefully and reduce it, utilizing most of the exhaust steam for hot water purposes, thereby eliminating live steam. Raise feedwater temperature as high as possible without jeopardizing pump operation; check for possible steam trap leaks (the largest evil).

I would install condensate meters in order to establish evaporating records with which he then could be guided as to the approximate steam rate of the hot water and engine. By all means drill and tap the engine cylinder for the purpose of attaching an engine indicator.

Has the possible economy of electric driven line shafting vs. steam driven been given consideration?

I shall be glad to assist him further without obligation or remuneration. In view of our National Emergency and the priority situation, I am willing upon request to lend him, without charge, condensate meters which will enable him to establish evaporating records.

Schenectady, N. Y. CARL BACHMANN

Answer No. 205

How Much Condensing Water Is Needed Here?

How CAN I determine the amount of water to condense a certain amount of steam? asked F. J. S. in the December, 1942, issue. He then went on to state the reason for the question. His turbine, a 500-kw., 170-lb. pressure, 80 deg. F. superheat unit was installed in 1918, ran non-condensing until 1922, then an 850 sq. ft. surface condenser was added. Steam conditions then were 150 lb., no superheat. The steam consumption was 18 lb. per kw-hr. The temperature rise of the condensing water was 30 deg. F., from 52 to 82 deg. F. In 1932, steam at 170 lb., 420 deg. F. was supplied to the turbine through a reducing station from new 250-lb., 600 deg. F. boilers. Today his steam consumption is 28 lb. per kw-hr. with a condensing water temperature rise of 40 deg. F., giving a vacuum of 18 to 20 in. He does not know how much condensing water he is now using. He gave the condenser manufacturers' guarantees for four conditions. Finally he asked if an air leak would be indicated if there is a difference of more than 6 or 8 deg. F. between steam and condensate temperatures.

The various answers to this question show the methods of computation involved and are substantially in agreement on all points. All the commentators agree on the possibility of air leakage. Bill Maddock's comments were published in the May issue. Here are some more.

Calculations by Schmoker

THE APPROXIMATE amount of cooling water can be figured in the following way:

From the steam table we find (using absolute pressures)—Steam at 170 psi., 420 deg. F., contains 1228 B.t.u. per lb. Temperature of the condensate at 5 lb. absolute pressure or 10.18 in. Hg. below a 30-in. barometer reading is 160 F. Condensate contains 128 B.t.u. per lb.

A kilowatt-hour is equal to 3413 B.t.u.

Cooling water rise is considered 40 deg.

500 kw-hr. at 28 lb. of steam per kw-hr. equals 14,000 lb. of steam per hr.

The quality of steam is considered to be 90 per cent.

B.t.u. of a pound of steam used in the turbine equals $\frac{3413}{28} = 122$ B.t.u.

B.t.u. of a pound of steam entering condenser is $0.90 \times 1228 - 122 = 984$ B.t.u.

Heat to be absorbed by condenser, $984 - 128 = 856$ Btu per lb.

Circulating water per lb of steam $\frac{856}{40} = 21.4$ lb.

Pounds of circulating water required $= 14{,}000 \times 21.4 = 299{,}600$ lb.

Gallons per minute $= \frac{299{,}600}{60 \times 8.33} = \frac{4996}{8.33} = 599.7$ g.p.m.

These figures were taken for a steam consumption of 14,000 lb. per hr. If the load is less, less cooling water would be used. Using the figure of 572 g.p.m. given as the consumption on a previous test, we would have:

$572 \times 8.33 \times 60 = 285{,}285$ lb. cooling water per hr.

Pounds of steam per hour would be $\frac{285{,}285}{21.4}$ or 13,331

Kilowatt-hours would be $\frac{13{,}331}{28}$ or 475 kw-hr.

A comparison between the two tests would reveal that the turbine is now using 13,331 lb. of 1228 B.t.u. per lb. steam per hr. to generate 475 kw-hr. that were generated previously by 8550 lb. of steam having a heat content of 1194 B.t.u. per lb. The thermal efficiency would now be about 10 per cent compared to 15.8 per cent in the previous test.

The low vacuum and the high rise in cooling water temperature would indicate an excessive amount of air entering the condenser. Not knowing the type of air removal equipment used, it is hard to suggest exactly what should be done. In any case, all parts subject to vacuum should be thoroughly inspected for air leaks. This would include any piping, the condenser, the turbine exhaust section, the atmospheric relief valve, air removal equipment, etc.

It must be remembered that it is much harder to cool air than steam and that a 10 deg. drop in condensate temperature will increase efficiency about 1 per cent.

Wilmette, Ill. E. O. SCHMOKER

More Water Needed, Taylor Thinks

THE QUESTION of required condensing water in this problem requires several assumptions for a practical solution.

1. Assume full load of 500 kw. on turbo-generator unit.

2. Assume water rate of 22 lb. per kw. with 1000 B.t.u. per lb. latent heat.

3. Assume 28 in. Hg. vacuum desired on surface condenser (101 deg. F.).

4. Assume 8 deg. F. terminal difference between condensate and cooling water temperature leaving condenser.

5. Assume 15 deg. temperature rise in condenser or cooling range of cooling tower (good practice).

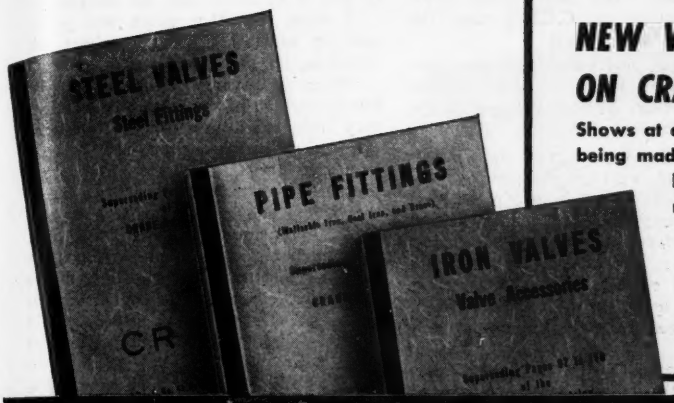
6. Assume a mechanical draft cooling tower is used for cooling water to within 6 deg. of a 72 deg. F. wet bulb temperature, resulting in 78 deg. F. cold water temperature from the cooling tower to the condenser.

Proof: 101 deg. F. — 8 deg. T. D. = 93 deg. F. temperature of water leaving condenser —78 deg. water entering condenser = 15 deg. temperature rise in condenser or cooling range of tower.

On this basis the total heat load on the condenser would be 500 kw. × 22 lb. W.R. × 1000 B.t.u. per lb. or 11,000,000 B.t.u. per hr. and the cooling water required would be:

$$\frac{\text{11,000,000 Btu per hr heat load}}{\text{8.3 lb per gal} \times \text{15 deg} \times \text{60 min}} = 1472 \text{ gpm}$$

Since the condenser manufacturers performance guarantees seem to be based on using only 500 g.p.m. of 55 deg. to



NEW WARTIME CATALOG SERVICE ON CRANE PIPING PRODUCTS . . .

Shows at a glance all items obtainable and those not being made under Simplification program of National Bureau of Standards. Saves time for piping maintenance men, specifiers, buyers.

WHAT'S BEING MADE AND WHAT ISN'T

IT'S basic home front strategy—simplification of lines. It is conserving vital materials and allowing greater production of most essential products. It enabled Crane, for example, to double and re-double the output of necessary valves and fittings for the Army, Navy, and war industries.

But to keep production lines flowing, piping men must know what equipment is being made and what isn't. Regular catalogs become quickly obsolete. So—to save time for maintenance men, specifiers and buyers, and make their jobs easier, Crane has introduced this novel cataloging service on piping products under the Simplification program.

With an individual section for each class of product, innovation of this catalog service is that its pages are reproductions from the latest Crane general catalog, but with special markings instantly showing all products eliminated as well as those available. Noteworthy is that Crane still offers the broadest selection of valves and fittings for every service.

Most plants have these emergency catalogs. Under present operating conditions, their regular usage offers many important benefits. You can depend on them for the accurate specifications, application and ordering data necessary to keep pipe lines flowing for Victory. Crane Co., 836 S. Michigan Ave., Chicago, Ill.

ARMY E NAVY

CRANE VALVES

Piston Valve Replacing Slide Valve Will Help a Lot, Says Heiwig

As WE ALL KNOW, these old timers were built to pull or work like hell—and likewise to hell with the water rate. I have seen some of these old gals with as much as 1 in. clearance, as well as a steam valve port 12 to 14 in. long. How can you remove shims to take up this excess clearance?

We know that most of these engines were built for 75 to 100 psi gage steam pressure. We also know that you can take a slide valve and plane it, also the seat, scrape it into a perfect seat, start the engine up and the valve will warp in spite of everything. How are you going to keep a low water rate with that kind of valve?

What did the railroads of our country do? They went to piston valves and gun metal liners for cylinders and valve chambers.

It has not been so long ago that I saw an old Buckeye cross-compound with Meyers riding cutoff changed from the old-style D or flat valve to a Baker piston valve and the steam consumption was reduced by 40 per cent. This old engine was bought in 1881 and she is still turning over every day, doing 600 Ihp. The low pressure valve in this old engine weighed 1750 lb. Try to keep it from warping! I also saw a Baker valve placed in a slide-valve engine of very early date, which also showed a reduced steam consumption; this engine is of a very good make with a good shaft governor.

As to the steam engine indicator, good advice.

I would say to L. M. J. vL.: Have a Baker valve installed, rebore the cylinder and install a piston that will reduce the clearance to as small an amount as possible and I can assure him of pleasing results.

Seymour, Ind. WM. F. HEIWIG

Carl Bachmann Suggests Stopping Heat Losses and Makes an Offer

How about lowering initial pressure to 100 psi.? If I remember correctly, operating pressure of ironer shall not be in excess of 100 psi. Observe and check engine back pressure carefully and reduce it, utilizing most of the exhaust steam for hot water purposes, thereby eliminating live steam. Raise feedwater temperature as high as possible without jeopardizing pump operation; check for possible steam trap leaks (the largest evil).

I would install condensate meters in order to establish evaporating records with which he then could be guided as to the approximate steam rate of the hot water and engine. By all means drill and tap the engine cylinder for the purpose of attaching an engine indicator.

Has the possible economy of electric driven line shafting vs. steam driven been given consideration?

I shall be glad to assist him further without obligation or remuneration. In view of our National Emergency and the priority situation, I am willing upon request to lend him, without charge, condensate meters which will enable him to establish evaporating records.

Schenectady, N. Y. CARL BACHMANN

Answer No. 205

How Much Condensing Water Is Needed Here?

How CAN I determine the amount of water to condense a certain amount of steam? asked F. J. S. in the December, 1942, issue. He then went on to state the reason for the question. His turbine, a 500-kw., 170-lb. pressure, 80 deg. F. superheat unit was installed in 1918, ran non-condensing until 1922, then an 850 sq. ft. surface condenser was added. Steam conditions then were 150 lb., no superheat. The steam consumption was 18 lb. per kw-hr. The temperature rise of the condensing water was 30 deg. F., from 52 to 82 deg. F. In 1932, steam at 170 lb., 420 deg. F. was supplied to the turbine through a reducing station from new 250-lb., 600 deg. F. boilers. Today his steam consumption is 28 lb. per kw-hr. with a condensing water temperature rise of 40 deg. F., giving a vacuum of 18 to 20 in. He does not know how much condensing water he is now using. He gave the condenser manufacturers' guarantees for four conditions. Finally he asked if an air leak would be indicated if there is a difference of more than 6 or 8 deg. F. between steam and condensate temperatures.

The various answers to this question show the methods of computation involved and are substantially in agreement on all points. All the commentators agree on the possibility of air leakage. Bill Maddock's comments were published in the May issue. Here are some more.

Calculations by Schmoker

THE APPROXIMATE amount of cooling water can be figured in the following way:

From the steam table we find (using absolute pressures)—Steam at 170 psi., 420 deg. F., contains 1228 B.t.u. per lb. Temperature of the condensate at 5 lb. absolute pressure or 10.18 in. Hg. below a 30-in. barometer reading is 160 F. Condensate contains 128 B.t.u. per lb.

A kilowatt-hour is equal to 3413 B.t.u.

Cooling water rise is considered 40 deg.

500 kw-hr. at 28 lb. of steam per kw-hr. equals 14,000 lb. of steam per hr.

The quality of steam is considered to be 90 per cent.

B.t.u. of a pound of steam used in the turbine equals $\frac{3413}{28} = 122$ B.t.u.

B.t.u. of a pound of steam entering condenser is $0.90 \times 1228 - 122 = 984$ B.t.u.

Heat to be absorbed by condenser, $984 - 128 = 856$ Btu per lb.

Circulating water per lb of steam $\frac{856}{40} = 21.4$ lb.

Pounds of circulating water required $= 14{,}000 \times 21.4 = 299{,}600$ lb.

Gallons per minute $= \frac{299{,}600}{60 \times 8.33} = \frac{4996}{8.33} = 599.7$ g.p.m.

These figures were taken for a steam consumption of 14,000 lb. per hr. If the load is less, less cooling water would be used. Using the figure of 572 g.p.m. given as the consumption on a previous test, we would have:

$572 \times 8.33 \times 60 = 285{,}285$ lb. cooling water per hr.

Pounds of steam per hour would be $\frac{285{,}285}{21.4}$ or 13,331

Kilowatt-hours would be $\frac{13{,}331}{28}$ or 475 kw-hr.

A comparison between the two tests would reveal that the turbine is now using 13,331 lb. of 1228 B.t.u. per lb. steam per hr. to generate 475 kw-hr. that were generated previously by 8550 lb. of steam having a heat content of 1194 B.t.u. per lb. The thermal efficiency would now be about 10 per cent compared to 15.8 per cent in the previous test.

The low vacuum and the high rise in cooling water temperature would indicate an excessive amount of air entering the condenser. Not knowing the type of air removal equipment used, it is hard to suggest exactly what should be done. In any case, all parts subject to vacuum should be thoroughly inspected for air leaks. This would include any piping, the condenser, the turbine exhaust section, the atmospheric relief valve, air removal equipment, etc.

It must be remembered that it is much harder to cool air than steam and that a 10 deg. drop in condensate temperature will increase efficiency about 1 per cent.

Wilmette, Ill. E. O. SCHMOKER

More Water Needed, Taylor Thinks

THE QUESTION of required condensing water in this problem requires several assumptions for a practical solution.

1. Assume full load of 500 kw. on turbo-generator unit.

2. Assume water rate of 22 lb. per kw. with 1000 B.t.u. per lb. latent heat.

3. Assume 28 in. Hg. vacuum desired on surface condenser (101 deg. F.).

4. Assume 8 deg. F. terminal difference between condensate and cooling water temperature leaving condenser.

5. Assume 15 deg. temperature rise in condenser or cooling range of cooling tower (good practice).

6. Assume a mechanical draft cooling tower is used for cooling water to within 6 deg. of a 72 deg. F. wet bulb temperature, resulting in 78 deg. F. cold water temperature from the cooling tower to the condenser.

Proof: 101 deg. F. — 8 deg. T. D. = 93 deg. F. temperature of water leaving condenser —78 deg. water entering condenser = 15 deg. temperature rise in condenser or cooling range of tower.

On this basis the total heat load on the condenser would be 500 kw. × 22 lb. W.R. × 1000 B.t.u. per lb. or 11,000,000 B.t.u. per hr. and the cooling water required would be:

$$\frac{11{,}000{,}000 \text{ Btu per hr heat load}}{8.3 \text{ lb per gal} \times 15 \text{ deg} \times 60 \text{ min}} = 1472 \text{ gpm}$$

Since the condenser manufacturers performance guarantees seem to be based on using only 500 g.p.m. of 55 deg. to

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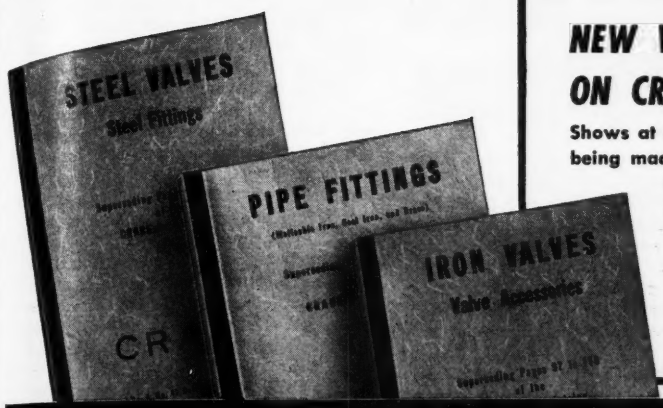

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ARMY E NAVY

CRANE VALVES

60 deg. F. inlet cooling water for this 850-sq. ft. condenser, assumed to have three passes, it seems reasonable to limit the cooling water quantity to less than 1000 g.p.m. It is quite possible this condenser was designed to use cooling water below 70 deg. F. which is seldom obtainable during summer operation, and 55 deg. to 60 deg. cooling water would probably be obtainable in the summer months only from a deep well or spring fed stream, well protected from the sun rays. A mechanical draft cooling tower cannot provide such cold water temperatures in the summer time.

F.J.S. states at the present time the steam consumption is about 28 lb. per kw-hr. with a cooling water temperature rise of 40 deg. F. resulting in 18 in. to 20 in. Hg. vacuum, but the condensing water quantity is not known. With a 475-kw. load × 28 lb. W.R. × 1000 B.t.u. per lb., there will be a heat load of 13,300,000 B.t.u. per hr., which, divided by 8.33 lb. per gal. × 40 deg. F. temperature rise × 60 min. equals 665 g.p.m. of cooling water required. To obtain the initial and final water temperatures with this operation we take the condensate (also steam) temperature corresponding to 20 in. Hg. vacuum (163 deg. F.) and then subtract the above mentioned 8 deg. terminal difference and find the hot water temperature is 155 deg. F. Then subtract the 40 deg. temperature rise to find the cold water temperature of 115 deg. F. These figures would seem to answer the question regarding cooling water being used at the present time. However, the water temperatures indicate there is a deficiency of circulating water and the increased pumping costs for circulating approximately 1500 g.p.m. would pay for lowering the water rate to about 20 lb. to 22 lb. per kw. or a saving of about 3800 lb. per hour of steam.

A difference in temperature of 6 deg. or 8 deg. F. between the steam entering the condenser and the condensate leaving the hot well would not necessarily indicate air leakage. Thermometers should be calibrated for accuracy as they are often 5 deg. to 10 deg. in error.

Milwaukee, Wis. W. J. TAYLOR

Answer No. 215

Simplex Pump Piston Sticks at Low Speeds

WHEN the 5 by 8 by 12 in. simplex vacuum pump piston kept sticking mostly at the end of the stroke, C. E. D. had the pump overhauled, as described in the February issue but it continued to stick. He asked what the cause and cure might be.

Trouble Is in Valve, says Baker

WE ONCE had a pump which "acted up" as does C.E.D.'s. In our case instead of the pump being used in vacuum service it was used for boosting water pressure for desuperheating.

For a while after the pump was installed an attempt was made to run the pump without any oil, so that the exhaust could be put back in the low pressure system. This didn't work so well. We then thought by throwing the steam away and oiling we could correct our troubles. We later found after trouble similar to C.E.D.'s that the pump valves were ruined.

On casual observation the valve surfaces all seemed in good shape but on close inspection we found ridges in the center and at each end of the valve.

Rather than try to grind these ridges out by hand, we took the pump to the machine shop, placed it in a planer and with an emery wheel mounted in the tool post resurfaced the entire valve area. By the way, just as soon as the emery wheel had made a cut or two across the valve area, the difference in light shadows made the ridges appear very distinct.

The pilot and piston valve were resurfaced in the lathe. After these parts were resurfaced we lapped them in with fine valve grinding compound. The pump was then assembled, a mechanical two pump type of lubricator installed and the pump started up. The pump hasn't given any trouble since.

Each year we go into the pump, touch up the surfaces with fine valve grinding compound, using a flat cast iron plate so as to keep the valve surface true and free from ridges. We believe this is better than lapping the valves in as there is no chance of getting the valves set in a groove.

It might be possible to go much longer than a year without touching this pump but we don't take a chance. It's on our maintenance schedule so we give it the works.

Possibly C.E.D.'s oil trouble is due to his use of a hydrostatic lubricator. Some folks may be able to make one work properly but I never could. Either they stay full until someone thinks to "fill" them again or they empty themselves within ten or fifteen minutes after filling. The result of this, of course, is either a flood of oil or none, which is of no value in oiling a pump in constant service. With the single pump lubricator we have had trouble with the feed indicator fouling just as the glasses in the hydrostatic. True this fouling is usually the fault of the operator who "feels" that more oil is needed and pumps in quite a bit by hand, thus flooding the glass.

Our condemnation of a piece of equipment because we don't get results when we operate it improperly hardly seems fair, but at least we admit the error is ours.

If C.E.D. will work over his pump as described above I feel certain he will be satisfied with the results.

Clearwater, S. C. R. C. BAKER

Williams Had a Pump With the Same Disease

Your problem reminds me of a similar case I once encountered. The pump was a simplex 8 by 6 by 12 in. unit, evidently built for high pressure work such as boiler feed, but serving as a vacuum pump on a small evaporating unit. The pump would race and bump the cylinder heads and, when throttled to normal speed, would soon stop. All the adjustments and minor repairs we were able to give it failed to help the situation.

I think that that pump and yours had the same disease and perhaps the following is a fair diagnosis.

When in operation, the air end piston is working in a vacuum and requires very little steam pressure in the steam cylinder. This steam pressure is controlled at the throttle and the reduced pressure is all that is available to throw the valve. The result is incomplete valve travel, or no travel, and the pump stops.

Your pump is better proportioned for the job, and if it is known that the pump has given satisfactory service in that work, then the proper repairs should rectify the trouble. Perhaps leakage from wear caused it to fail and, after the overhaul, the newly machined surfaces, together with strong, stiff valve piston rings made more friction than the steam could overcome.

If the pump has never worked properly, the steam piston may be too large. Possibly a liner and new piston could be installed, resulting in a higher operating pressure, and consequently, better valve action.

A small duplex pump would give good results, as they are almost entirely free from the troubles found with the simplex valve gear.

Devon, Conn. R. L. WILLIAMS

Answer No. 216

Examination Questions: Who Can Answer Them?

EXAMINATION QUESTION 4. A. What would you do to protect the wires coming out of a metal sheath cable, insulated for 13.5 kv. from mechanical injury and moisture? Ans.—Put them in a waterproof junction box.

B. How may water be removed from transformer oil? Ans.—Drain all the oil and run it through a separator.

C. How is transformer oil tested? Ans.—By applying the flash point test.

D. How would you get the transformer oil out of the drums? Ans.—I would pump the oil out of the drum.

E. You have just installed a bank of three transformers. All the electrical connections are complete. The transformers are oil cooled but have been shipped dry. The oil is in drums.

Tell, step by step, how you would put this bank of transformers into service.

Ans.—I would clean every transformer painstakingly, remove all waste matter from the inside of them and test all electrical connections. Then I would pump the oil into transformers up to predetermined level. This accomplished, I would report to the power house, requesting them to turn on a minimum of power, so as to find out any reversed connections. If this test could be called successful, an order for the complete load of power could be issued.

EXAMINATION QUESTION 5. A. Explain how you would install 10 lighting fixtures each consisting of four 20-watt fluorescent lamps. Ans.—Would use all existing outlets, switches and wires.

B. What, if any, auxiliary devices are

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required besides the tubular lamps? Ans. —No auxiliary devices are necessary if the electrical wiring is grounded.

C. How would you increase the power factor of the job installed in question No. 5-A? Ans.—The power factor doesn't have to be increased, because these fixtures are installed to promote a unity power factor.

EXAMINATION QUESTION 6. A room is 10 by 20 ft. There is one outlet in the center of the ceiling which is a flat terra cotta arch on which there is a plaster finish. You are to install two new outlets located 5 ft. in from the end and side walls. These new outlets are to be connected to the existing outlet which is to be blanked. The new work is to be concealed. The existing outlet is a standard 4-in. box.

A. Explain how you would do this job.

Ans.—When doing a job like that, B.X. or armored cable is best. In order not to destroy the arch, a channel must be chiseled out and the cable laid in it. The cable has to be fastened at certain distances with clamps which are screwed into raw plugs. When the B.X. is in place, I would cover these channels with plaster of Paris. If the cable or cables are installed at their respective lengths, an opening has to be broken on each side so as to be able to bring the outlets flush with the plaster.

B. Prepare a bill of materials for this job.

Ans.—Armored cable about 15 ft. (2 wire) No. 14.

Cable clamps. Raw plugs.
B.X. connectors. Complete bushings.
2 outlets, assuming double ones.
2 receptacles.
1 plate 4x4 to blank existing outlets.
Soldering iron, soldering material, rubber and friction tape.

Camp Ellis, Ill. CARL EGERTER

Answer No. 217

Is a 10-Amp Fuse Always a 10-Amp Fuse?

No Watt? No. Watt? It's I^2R That Counts

I THINK Mr. Deichmann is slightly confused about his watts in relation to fuse blowing. It is true that $I \times E = W$ but I think the formula has been applied wrong in this case.

The transposition of this formula to I^2R makes this problem seem simpler to me.

The R of the fuse being constant for all practical purposes, the only factor entering the fuse blowing problem is I.

If Mr. Deichmann has actually made tests of 250-v and 500-v fuses in series, with the 500-v fuse going first, it was probably due to variations or permissible tolerances in manufacturing. It is also possible that, intentionally or unintentionally, the 500-v fuse had a longer time lag and in Mr. Deichmann's test the current was raised at a rapid rate.

Years ago we used fuse wire; it came on spools like thread. We still use this fuse wire for checking clearances in split bearings. The labels on the spools rate the wire in amperes only; no mention is made of volts.

Clearwater, S. C. R. C. BAKER

Answer No. 220

What Makes the Marks On the Collector Rings?

He Says Grind 'Em and Quit Worrying About 'Em

I HAVE BEEN operating turbines since 1912, including about all makes. All these turbines had steel rings, I have had the same trouble. I have tried the ideas of both D. L. and Geo. McNally; also I have tried using different grades of brushes, lifting the brushes off the rings, reversing the leads and about everything else I could think of. The only remedy I have found is this: When they get bad enough, grind them and polish them. A long time ago I came to the conclusion that these marks were caused by some difference in frequency or oscillation and quit worrying about them.

Newport, Ky. C. D. DISPENNETTE

Answer No. 222

How Prevent Fuses from Blowing?

ALL HIS power fuses are 220 v and 30 amp. clear back to and including the main board. But an overload will blow these, shutting down everything, said A. H. P. in the April issue. Now, could he put two 30-amp. links in each of the main board fuses? If he did, how much would it increase amperage?

Fuse Tables Show Capacities

IF A. H. P. were to put two 30-amp. links in his 30-amp. fuse casings, the permissible amperage would be doubled. However, it is not a safe practice to install 60-amp. fuse links in a 30-amp. switch.

He states that overloads frequently blow out his 30-amp. fuses, which would indicate that some of his motors may not have sufficient fuse protection, whereas 30-amp. fuses may be too large for the smaller motors.

A. H. P. can easily obtain data or tables from the manufacturers of his motors and switching equipment that will enable him to determine the exact fuse amperage necessary to protect each individual motor. Extracts from such tables are reprinted below for 220 v., 3 phase, Std. Squirrel Cage Motors:

Hp.	Full Load Amps.	Running Protection	Starting Fuse	Branch Circ. Breaker
1	3.3	4.2	15	15
5	15	20	45	35
10	27	35	90	50
15	38	50	125	70

After each motor is provided with proper fuse protection, A. H. P. could ascertain the maximum number of motors that might be started simultaneously, also the maximum horsepower or kilowatt load on his main board fuses. Using this information and the tables, he could easily determine the exact amperage of fuse and switch necessary for his main board.

Morgantown, W. Va. DENARD L. GUSLER

Main Board Fuses Should Have Capacity of Total Load or More

STANDARD PRACTICE is to have a master switch mounted on the main board of a capacity greater than the total amperage of the entire load to be carried. The fuses are of the same capacity as the switch. Then each individual motor has its own switch carrying fuses of proper size to protect the motor. For example, if five motors are in use, each carrying a 30-amp. fuse, then the main switch would be about 200 amp., for the total load would be 150 amp. This allows for overload conditions. Then each motor would have its own switch carrying a set of 30-amp. fuses for protection. A. H. P. says he uses renewable fuses; then he can build them up to whatever will hold the load, provided that each motor has its own ample protection.

Baltimore, Md. CHAS. W. PARKS

Answer No. 221

Can He Connect 220-v Motor to Run on 110-v?

HERE is a more detailed comment on C.W.W.'s question in the April issue.

Yes—If You Can Accept Half Speed and Half Load

As suggested by Mr. von Dannenberg (June issue, page 110), the field coil winding should be opened at the central point by disconnecting the jumpers between the windings and the two halves of the field windings connected in parallel. This is not difficult and will have the effect of giving full field flux with the lower voltage.

The motor will now operate on the lower voltage but the speed and power will be cut in half. Usually it is not difficult to compensate for the reduction in speed when the drive can be modified. The fact that the power is halved means, of course, a high investment for the service rendered.

In many cases, the armature may be simply reconnected to operate on the lower voltage at little cost but it is well to remember that such a change may lead to commutation difficulties. When reconnected, the brush rigging must handle twice the current it was originally designed for; such changes may call for a new brush rig with larger or additional brushes. This should be checked with the manufacturer before having the armature reconnected, to be sure the brushes will carry the additional current without overheating or sparking.

In view of the above factors, it might safely be said that a 220-v motor can be operated satisfactorily on 110 v if one is satisfied to operate it at half speed and half load.

Philadelphia, Pa. THOS. W. BENSON

NO TWO BOILERS ALIKE

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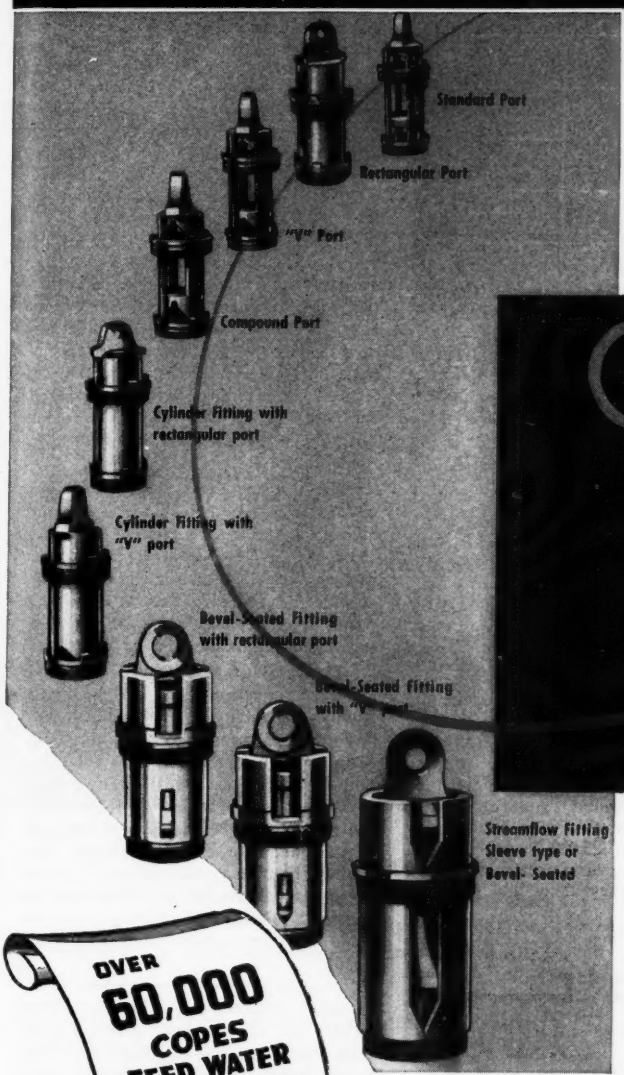

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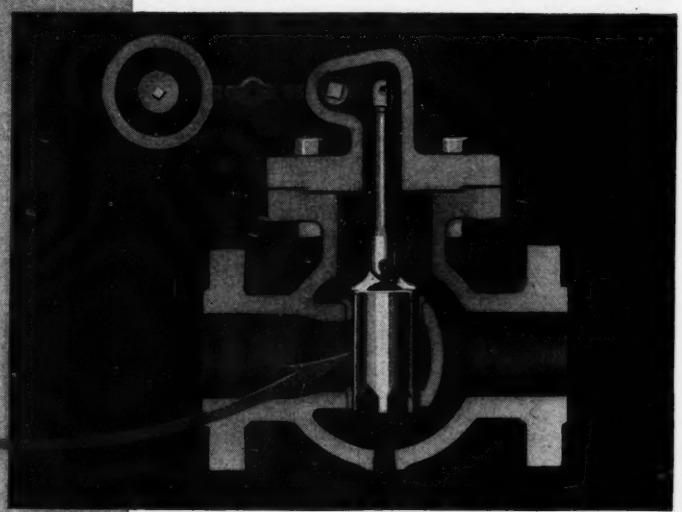

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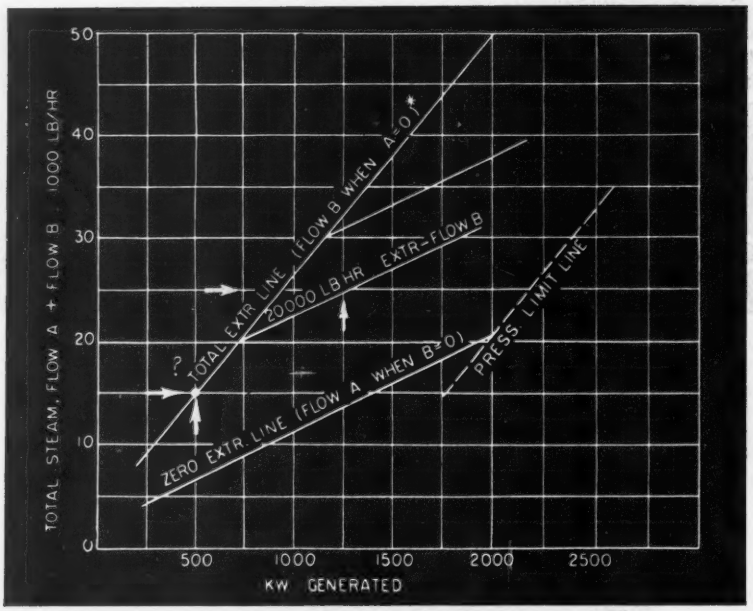


Left—Turbine Extraction Chart

***Taken as zero for simplicity, neglecting ventilating steam to exhaust**

Turbine Extraction Chart[1]

By H. STEEN-JOHNSEN

Turbine Engineering Department, Elliott Company

"GIVE US more steam" is the request from the paper mill. "We can't," is the reply from the power house, "You are not pulling enough load."

Strange talk this, when that extraction turbine has such a big pipe connected to it. The mill is running slow on heavy stuff, and it is coming off all wet with the drier valves all wide open.

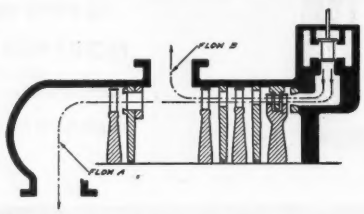
The chief engineer stands his ground and pulls out the manufacturer's extraction chart to plead the case for the defense, and the superintendent is skeptical. He has heard that you can prove anything by curves.

Such cases frequently come up where the extraction turbine has to cover wide variations in process demand. Sometimes it is caused by a load condition that was not anticipated in the plant layout, and at other times the limitations of the equipment are not understood.

A good way to explain the chart and the action of the turbine is to think of the turbine as having two steam flows, A and B, as indicated in the accompanying sketch. Flow A goes from the inlet to the exhaust, and flow B, from the inlet to the extraction point, and then out to the process. The power generated by the steam depends upon the pressure drop and the quantity, in the conventional manner.

Thus, if A and B are equal, flow A will generate more kilowatts than flow B, because it is subjected to a greater pressure drop.

It must be understood that a definite amount is generated for every flow of A, and for every value of flow B. Therefore, if flow B is fixed by the process, then a definite output is also fixed as the power generated by flow B. For a certain turbine this may be 1250 kw for a flow B of 25,000 lb per hr, and, if the electrical load is greater than 1250 kw flow, A comes along and takes its



share of the burden. But if the load on the turbine is less than 1250 kw, then the 25,000 lb of steam will drive the speed up, the governor will shut off the steam, and the paper mill won't get enough steam for the driers unless a reducing valve is brought into play. These simple rationalizations and some more are portrayed in the extraction diagram, in terms of tangible pounds of steam and effective kilowatts. The vertical co-ordinate represents the total steam flow, through the turbine inlet, the sum of flows A and B, and the horizontal co-ordinate shows the total kilowatts generated. The zero extraction line represents the steam flows required for various loads when flow B is zero, that is no steam extracted. The total extraction line represents the steam flows required when flow A is zero, that is, when all the steam is extracted. The extraction lines give the total steam flow for various kilowatt loads when the flow indicated is extracted. Thus, if we believe the chart, 1250 kw with a flow B to the extraction line of 20,000 lb would require a total flow of 25,000 lb per hr. By indulging in some kitchen arithmetic, flow A is obtained as the difference between total flow and flow B, that is 5000 lb.

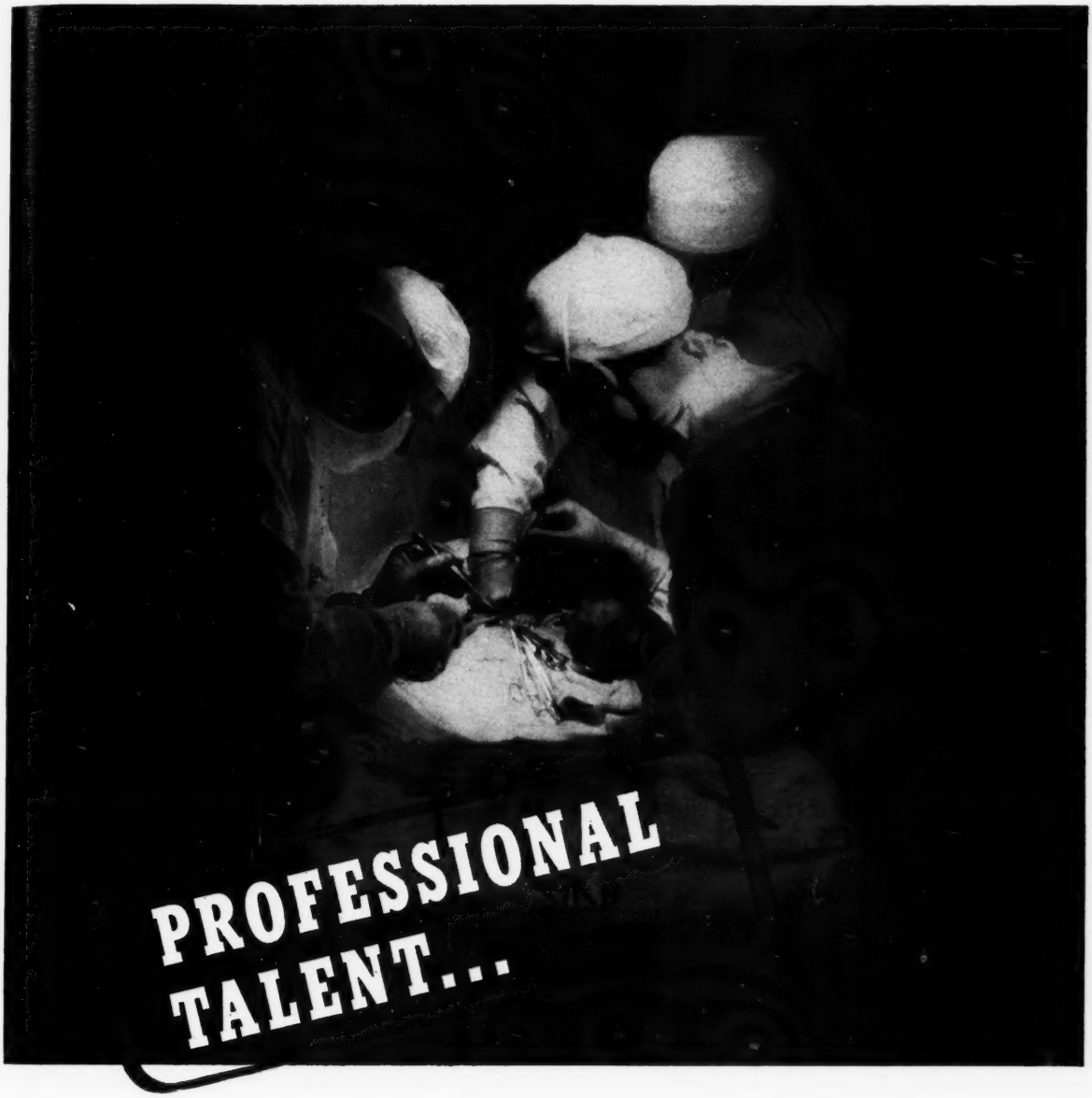
At 700 kw the 20,000-lb line terminates in the total extraction line, and at 500 kw there is no 20,000-lb extraction line. The story as told by the chart is that if the paper mill driers need 20,000 lb of steam, the turbine must be loaded to at least 700 kw. At 500 kw, the turbine will give 15,000 lb for flow B, and to get 20,000, an additional 5000 lb must be supplied by a reducing valve.

The pressure limit line is the limit line for flow A, and is the upper terminus for the extraction lines. To the right of this line, flow A exceeds the capacity of the turbine exhaust, and no more steam can make its exit by that route; as a result, the extraction pressure builds up when this line is crossed.

As a conclusion it may be said that the operating limits of the extraction turbine are between the total extraction line and the pressure limit line, with the size of the turbine inlet as the upper limit, and the zero extraction line as the lower limit. Inside of these limits the turbine is free to perform and satisfy demands for extracted steam. And if these limiting conditions are fully understood, and considered in the original design, a most satisfactory system, capable of the necessary flexibility, is the result.

SOME SIGNIFICANT turbine operating figures for the ten-year period ending with the year of 1941 compiled by the E.E.I. Prime Movers Committee are as follows: Average rating of units reported has increased by 4480 kw, turbine annual inspection outage has varied between 57.22% and 74.19% of the total outage hours, bucket or blade repair outages reached a maximum of 13.51% of the total outage hours in the year 1931 and dropped to a minimum of 4.40% in 1935, average outage hours per unit varied from 535 to 754 comprised mostly of turbine causes with the condenser second in importance.

[1]Reprinted from the Summer 1943 edition of "Powerfax."



The work of the water conditioning specialist may not be as spectacular as that of the surgeon, but these activities have a common denominator of training, knowledge and skill.

There are wide fields for the application of professional talent in the conditioning of boiler feed water. Under today's conditions the prevention of scale, corrosion, embrittlement and carryover is a subject of particular importance. Betz engineers and chemists have had years of experience with all types and sizes of installations and with widely varying feed waters. Our service is complete for all industries, with individual recommendations for each client.

We have laboratories and engineers located throughout the United States and Canada.

W. H. & L. D. BETZ
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BETZ

● **CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS**

If Uncle Sam Drafts Your Refrigerating Compressors—*

You can still maintain air conditioning service if he leaves you any refrigeration equipment. Perhaps you can use some of the ideas and data presented by Mr. Fleisher to increase the capacity of the equipment remaining. Or perhaps you can stretch the remaining capacity to maintain less than the optimum conditions but better than with no conditioning. "All of us must impress on the government and on the public," says Mr. Fleisher, "that if we consent to forego summer conditioning today it is because we recognize the emergency and not because we concede for a moment that air conditioning and refrigeration have not been productive of better goods and better people, who are able to produce better and more goods and better ideas for the prosecution of the war."

By WALTER L. FLEISHER, *President, Air & Refrigeration Corp.*

NON-ESSENTIAL USERS of refrigeration, such as department stores, office buildings and the like, can exist without refrigerated air conditioning. It may be uncomfortable, but after all it took some of them a long time to make up their minds they had to have it.

The silver lining of this cloud, as far as the refrigeration manufacturer is concerned is this: When these various stores remove the refrigeration or tell it to the government, they are no worse off than they were before they had refrigeration, and no worse off than their neighbors. When the war is over, they won't take second-hand refrigeration, but will want new air conditioning, creating work for the refrigeration manufacturer and the contractor at a time when this type of work will probably be very scarce.

Long before WPB put an end to the manufacture of refrigerating machines, it established a priority on refrigerants, which made all who had Freon or ammonia machines wonder whether they would be able to operate their machines this coming year, even though they had the apparatus.

It didn't seem to me that the refrigerants had anything much to do with the restrictions. So I asked my friend, R. J. Thompson of Kinetic Chemicals, Inc., who laughed at the idea of scarcity of any of their derivatives. He says they have a capacity of 1,800,00 lb per month, which has been in excess of any demands they have had, and that there is no shortage.

I feel confident that the fear of not being able to get the refrigerants necessary for the operation of their cooling system is one of the main reasons that department stores, for instance, are so eager to cooperate with WPB in the release of their apparatus for essential work.

If a case comes up where a particular installation or the equipment from that installation can be used advantageously in a new war job, the manufacturer who furnished the equipment is going to be requested to give a definite figure on its removal, including a satisfactory price to the owner, which is to take into account obsolescence and to include revamping and re-installing this equipment in some other place. The Defense Plant Corporation will pay the owner for the value of the apparatus, relieving the manufacturer of the burden of financing.

As this work is to be of a competitive nature, the manufacturers are extremely anxious that false ideas on the capacity and efficiency of old equipment should not permeate the public mind.

Increasing Capacity of Machines Left

Let us assume that we have a refrigerating machine and that we are either going to make an extension of the plant or that we are going to use part of our capacity—that is, that one of two machines is going to be removed. The problem, then, is to see whether we can increase the capacity of the machine we have left. Or let us assume that we are getting a machine from some other source for emergency operation and we want to get more from it than its rated capacity. In this particular machine we have a suction temperature of 40 F and a condensing temperature of 95 F. The machine is running at 485 rpm with 94.3 brake hp and 300 gal of 75 F water per min for condensing purposes. Keeping the suction temperature the same and the condensing temperature the same, raising the speed to 600 rpm increases our brake hp to 121 and, with 375 gal of water, 123 tons capacity can be obtained with this machine.

If, in this same machine, the suction temperature is raised to 47.5 F, the entering and leaving condensing water temperatures remain the same—that is, 75 and 95 F; running the machine at 600 rpm, with 495 gal of condensing water, 145 tons of refrigerating capacity can be obtained from this machine at the expenditure of 125 hp. This additional amount of water can be put through the same condenser, but, of course, with an increased horsepower on the pump. The heat balance formula for this particular problem is based on pounds of refrigerant x latent heat handled in a constant volumetric machine at different rpm's as against the sensible heat transfer of the condensing water for the change of sensible to latent heat, plus the mechanical inefficiencies of the system.

Referring to Figs. 1, 2 and 3, it must be borne in mind that there are limiting factors. It is often difficult to pump the additional amount of water necessary with increased refrigeration through the existing condensers, or, if the amount of water or gases through the evaporator is changed, a friction coefficient may be set up, which will require additional pumps or additional pumping, which may very seriously affect the operation of the system.

Stretching the Capacity Over the Entire Load

What are some of the things that can be done to overcome the deficiencies? Each manufacturer has different characteristics in his machine, which are particularly noticeable beyond the picked range.

In a large war plant, I indicated that if the conditions in the proposed building were raised beyond the point that they had desired, but within the allowable range of working conditions, they

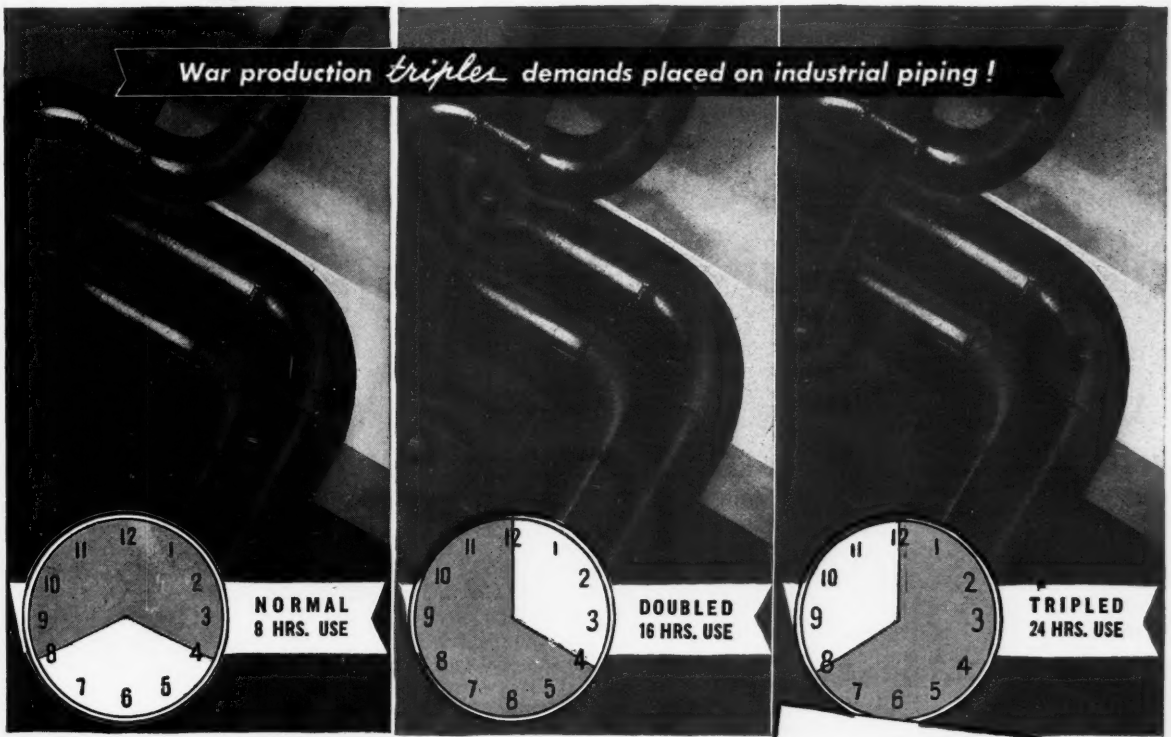
*Extracted from paper entitled Salvaging Existing Refrigeration for Emergency Work presented Nov. 17, 1942, before Cleveland Section ASH&VE and published in Refrigerating Engineering, April 1943.

NO. 7 OF A SERIES

HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

Welding with TUBE-TURN fittings gives extra strength and trouble-free performance needed today to insure uninterrupted piping service



'ROUND the clock, war-time operation for 24 hours a day instead of the normal 8 hours period *triples* the wear of oil, gas, power, chemical, heating, air, refrigeration and marine piping today.

Despite the extra strain that fittings naturally take, coupled with constant three-shift operation, Tube-Turn welding fittings are *practical insurance* against piping failures. Tube-Turn fittings are *stronger and safer* because of their exclusive construction advantages. They provide leakproof, trouble-free joints that last as long as the pipe itself. They can be installed faster and easier, can be quickly insulated, instantly eliminate maintenance worries, and provide streamlined, space-saving layouts.

Sizes, types and weights are available for every industrial requirement. *Write for catalog and data book No. 111.*

OTHER IMPORTANT WAR-TIME ADVANTAGES:

SPEED INSTALLATION: Less time needed for aligning, thanks to true circularity and uniform walls. Only simple butt welds required, easy even for novice welders. Whole sections can be preassembled on the ground.

SAVES CRITICAL MATERIAL: Absence of many flanges, bolts, nuts and heavy cast steel construction saves many tons of metal in a single piping system.

LAST LONGER: Smooth inner walls—with no ridges, waves or scale—means less corrosion and longer life.

LESS PRESSURE LOSS: Because of full effective radius and exact O.D. and I.D. alignment with the pipe, the flow is more efficient and pressure loss is less.

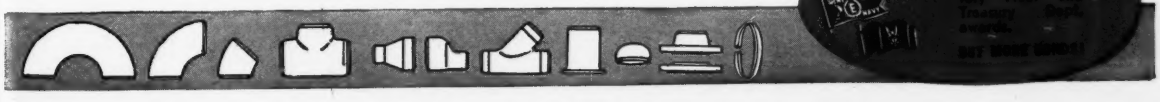
FEWER SUPPORTS NEEDED: Since welded piping weighs less and stands vibration better than flanged systems, few hangers or supports are required.

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

TUBE TURNS (Inc.), Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, Los Angeles. *Distributors in principal cities.*



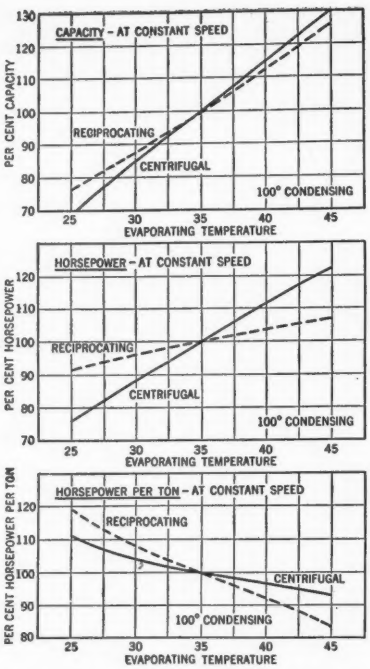


Fig. 1. The per cent of capacity, horsepower and horsepower per ton at constant speed, with different evaporating temperatures and constant condensing temperatures

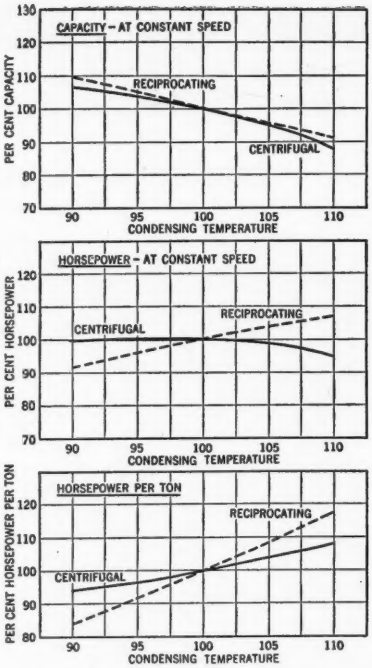


Fig. 2. The per cent of capacity, horsepower and horsepower per ton at constant speed, with different condensing temperatures and constant suction temperatures

could get by with their present refrigeration in the existing buildings, supplemented by a slight amount of well water. This was a new idea and consequently was *not* accepted, although the engineering was perfectly logical. The result is that they have one fully conditioned building and another of approximately the same size, adjacent to the conditioned building, in which there is no conditioning.

There is a possibility that in a department store which operates on a 10-hr schedule, after one-half or three-quarters of the refrigeration is salvaged for war purposes, if interesting results can be obtained, what is left of the system is allowed to operate 24 hr a day instead of 10. Let's assume that we have a design load of 200 tons and that the building has 6500 sq ft of 10-in. brick wall, 30,000 ft of 3-in. insulated roof, 47,000 ft of 6-in. concrete floor, and 25,000 sq ft of 6-in.

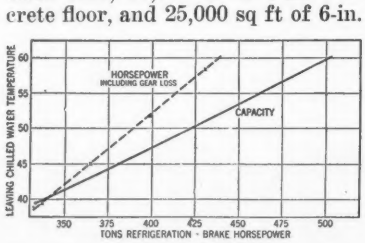


Fig. 3. Chart for capacity and horsepower, with different suction temperatures or chilled water temperatures

terra cotta partition. The brick wall has a mass of 650,000 lb; the roof, a mass of 150,000 lb; the floor, 3,000,000 lb, and the partition, 750,000 lb. The specific heat, of course, in each of these materials varies, the walls being 0.195, the roof 0.32, the floor 0.270 and the partitions 0.259. To heat or cool these masses one degree would absorb 1,179,000 Btu.

If all of this mass were cooled for, we will say, 14 hr, although part of it would be lost to out-of-doors during the day time, the balance that would be absorbed in the room or enclosure would be sufficient to carry over a fairly comfortable condition for a large part of the day. In a way, this does not differ from the storage refrigeration problem, except that storage refrigeration is out of the question, as the equipment and strategic material essential for the building of the tanks and coils are usually not obtainable. If they are, and there is no reason why wooden tanks are not suitable for this storage refrigeration operation, then part of the loss of refrigeration can be made up for by operating the plant 24 hr a day and utilizing the ice that has been made for partial cooling or for cooling certain parts of the building.

Another angle to this whole problem, which holds out a bright future for the refrigerating engineers and manufacturers, is that the government, before it had to clamp down on the use of comfort air conditioning in industry, had taught workers to appreciate comfortable conditions. They also discovered that with comfortable conditions they could produce more goods. Capital and labor had a chance, because of the war, to realize that comfortable conditions are conducive to health and to the production of a greater volume of goods, with less rejects, and at a lower price.

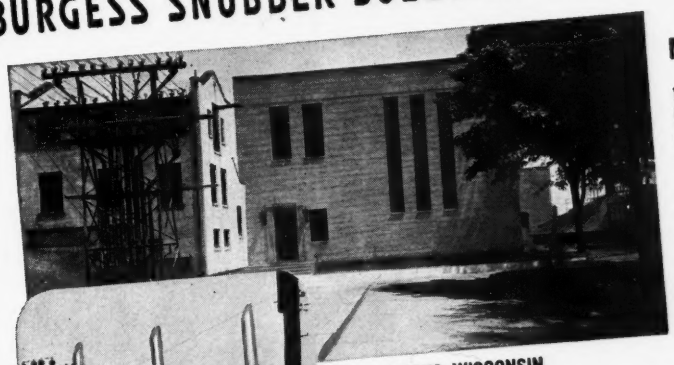
Accepting Less Comfort in Processes

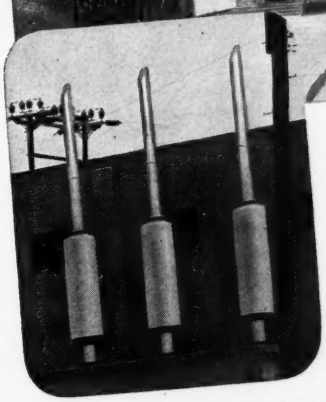
There is one other point, particularly in connection with the use of existing refrigeration for war plants requiring certain conditions for the material and the workers. There is a preconceived idea that a certain definite condition is required for maximum efficiency. This has, for many years, been considered to be 80 F, we will say, and 50 per cent relative humidity. The effective temperature research which was carried on by the American Society of Heating and Ventilating Engineers for a number of years indicated that 80 F dry bulb and 50 per cent relative humidity gave the same sensations of comfort as 77 F and 70 per cent, or 83 F and 30 per cent. At 77F dry bulb and 70 per cent relative humidity, we have a dew point of 66 F and at 83 F and 30 per cent we have a dew point of 48 F.

If we go back to our refrigeration machines to see what the difference in capacity might be with these different dew points, which approximately represent the evaporator temperature, we find on a particular machine that we could get 414 tons at 48 F, and at 68 F, if we extrapolate the curve, from a volumetric angle we might get around 600 tons, if it were possible to change enough of the other factors to accomplish this result. However, it would be essential to handle nearly three times as much air to get the same effective results.

If the material can stand that condition then we can let the temperature rise with the increased dew point to, say, 90 F and get along with about the same amount of air that we had before, but with a less comfortable condition than we had with 80 F dry bulb and 50 per cent relative humidity. However we will be producing possibly 50 per cent more refrigeration effect.

BURGESS SNUBBER BULLETIN on Diesel Exhaust Noise Control





COLUMBUS, WISCONSIN

Two years ago the municipality of Columbus, Wisconsin, put into operation its new Diesel plant, after the previous experience of operating a steam plant which proved to be more expensive than purchased power. The Diesel plant has been highly successful and is a model plant for the region.

All equipment installed here is of the finest, and the plant itself is kept in "showcase" condition. The exhausts of the three 875 hp. Worthington Diesel engines are equipped with Burgess Snubbers to assure that no obnoxious exhaust noise will bother nearby residents.

★ ★ ★

Chipley's New Book on Modern Spark Arrester Design

The favorable reception of Burgess' booklet by Chipley, entitled "Diesel Engine Exhaust Silencing," has encouraged the Acoustic Division to publish a similar booklet covering Chipley's investigation of the relative efficiencies of various means of separating sparks from exhaust gases. This booklet is available upon request and is offered with the sincere wish that it too may prove helpful.

Since engineer Chipley is now Lieutenant Chipley, assigned to the Army Air Force VIII Bomber Command stationed in England, the manuscript of this booklet was completed by an associate, Mr. Howard H. Darbo, who is patent counsellor for the Acoustic Division.

Like the preceding booklet, this one is an engineer's analysis of its subject. It details the development of the spark arrester from the first crude types used on woodburning locomotives to prevent fires, to the efficient Burgess Spark-Arrester, which removes 99.6% of solid matter from exhaust gases. Burgess Spark Arrester-Snubbers are widely used in marine and industrial installations. The Acoustic Division will be glad to send you a copy of this helpful booklet on request.

★ ★ ★

USING EXHAUST GAS ENERGY TO SCAVENGE AND PARTIALLY SUPERCHARGE TWO-STROKE-CYCLE ENGINES

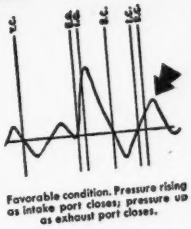
Every engineer familiar with crankcase scavenged two-stroke-cycle engines knows that good performance depends on obtaining the proper length of exhaust pipe as well as on scavenging air pressure.

Burgess engineers found that by properly tuning the exhaust system, exhaust gas energy will scavenge the cylinder without any help from crankcase air pressure, and also cause a partial supercharging effect.

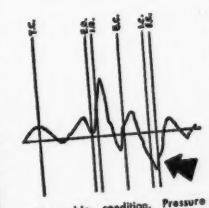
When the exhaust port opens at the bottom of the power stroke, burned gases expand into the exhaust pipe. The intake port then opens. If the exhaust system is properly tailored, pressure in the cylinder goes to atmospheric at about bottom dead center. Pressure in the cylinder continues to fall rapidly, and both burned gases and some clean air flow out through the exhaust pipe.

As the intake port closes, the gas flow reverses itself. Pressure rises as the air in the exhaust pipe rams back into the cylinder. By the time the exhaust port closes, the reverse flow has been sufficient to build up a pressure above atmospheric.

It may appear that this reversal of flow forces burned gas back into the cylinder.



Favorable condition. Pressure rising as intake port closes; pressure up as exhaust port closes.



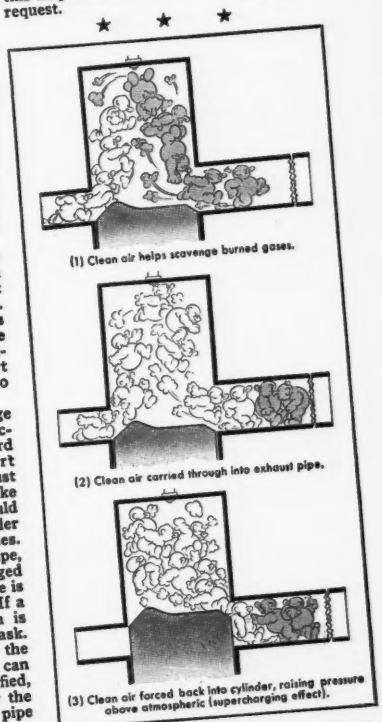
Unfavorable condition. Pressure below atmospheric as both ports close. Lack of clean air in cylinder will cause poor combustion.

However, if there is no undue restriction at the inlet, an excess of clean air will have passed across the top of the cylinder and into the exhaust pipe, and it is this clean air which is rammed back into the cylinder.

Of course, these pressure changes will not occur in this way unless the exhaust system is properly tuned. The object is to get the gases to oscillate in exactly the right way. Once this is accomplished, the intake port can be connected directly to the atmosphere.

It is necessary to arrange the system so that the direction of the flow is outward through the exhaust port from the time the exhaust port opens until the intake port closes. Then, air should flow back into the cylinder until the exhaust port closes. By using a telescoping pipe, its length may be changed gradually while the engine is running under full load. If a cathode ray oscillograph is available, it will greatly simplify this task.

Finally, a Snubber and tail pipe of the correct size for the engine in question can be installed. The Snubber can be specified, but it's a good idea to again employ the "trombone" pipe to find the exact tail pipe length for greatest efficiency.



(1) Clean air helps scavenge burned gases.

(2) Clean air carried through into exhaust pipe.

(3) Clean air forced back into cylinder, raising pressure above atmospheric (supercharging effect).

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JOB EVALUATION*

By D. M. MAGOR, Comptroller
York Ice Machinery Corp.
York, Pa.

DURING the past several years, The York Ice Machinery Corp., York, Pa., has conducted a comprehensive study on job evaluation to establish a future compensation policy upon the fairest possible basis.

This salary evaluation plan, though not looked upon as a model for every type of business, involves the services of a wide range of sales, engineering and manufacturing technicians and clerical employes.

No plan of salary evaluation has yet succeeded in eliminating, entirely, the element of opinion or judgment in the assignment of monetary values to the principal characteristics of each job. Such plans do, however, through uniform appraisal of job characteristics, reduce errors of judgment to a minimum and, for the vast majority of positions, provide salary ranges more nearly equitable in their relation to all other positions than could be achieved solely through the application of individual opinion.

Rather than depending upon a general personal opinion of the job as a whole, the York Salary Evaluation Plan incorporates the distinct advantage of requiring the appraising officers to examine and appraise the relative value of each part of the work and responsibility assigned to each job and to award, therefore, its proper worth.

"Point System" Rating

A total of 20 different job titles covering approximately 750 salaried employes were rated in this plan which is designed to measure in terms of "points," the principal qualities or characteristics found in varying degrees in most jobs. It involves the appraisal of those qualities and characteristics in terms of a common "point system," through which a comparative total value may be determined. This plan is based upon a total of 100 points.

The study of similar job rating plans revealed a number of different qualities and characteristics upon which ratings were based. These were consolidated into ten basic factors, as follows:

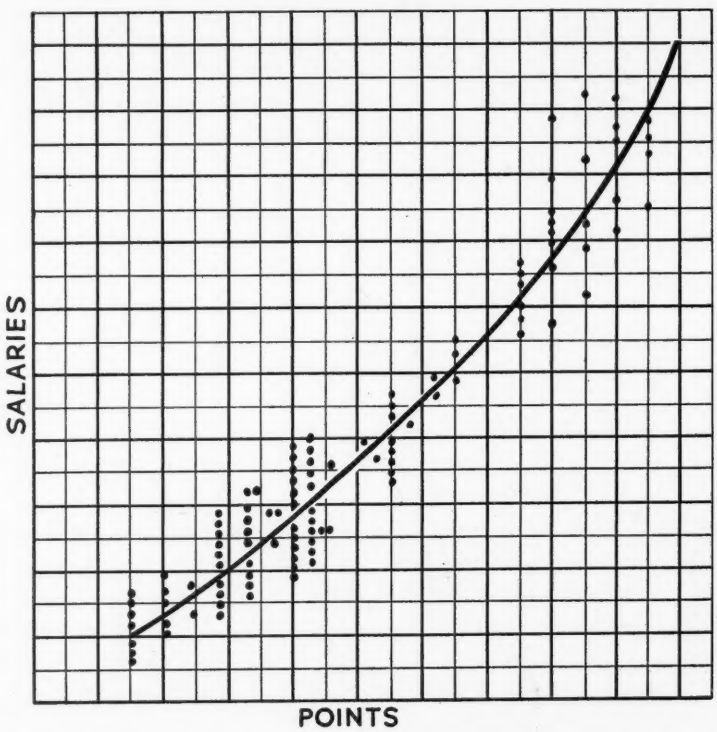
1. Education
2. Previous experience
3. Training time on the job
4. Standard duties
5. Supervision required
6. Resourcefulness
7. Quality requirements
8. Supervision exercised over others
9. Responsibility
10. Cooperation or personality

To each of these factors was assigned a maximum possible rating of 10 points. To illustrate the extent to which guesswork is minimized in the assignment of the correct number of points for any one of these factors, the following examples are shown:

Education

Education in this plan is defined as the formal preparation to do the job and is a measure of the mentality and general intelligence necessary.

Education need not necessarily be obtained in a recognized school, extension or correspondence course, but is the measure of the basic theoretical knowledge essential as a background for the job, acquired through any source. It should be distinguished from the practical application of such knowledge obtained through experience and training.



Each point shown on this chart represents the job of some salaried employe in the corporation. The curve drawn through the average of these points is the preliminary "Evaluation Curve"

* The material presented on this subject was taken from an original article in the Winter, 1942, edition of Cold Magic, a periodical published by the York Ice Machinery Corp.

Diesel engines sweep the 7 seas

Diesel engines power mine-sweepers —engines that must not fail these sturdy craft as they plough through heavy seas, clearing the way for troop ships and other Naval vessels. De La Vergne diesels are especially designed for this severe service.

De La Vergne has been a leading name in diesel engine manufacture for fifty years. From educational institutions in New England to pipe line stations in the Southwest; from dredges in the Gulf to cold storage houses in the Northwest—De La Vergne diesels have an enviable record of outstanding service and economical operation and maintenance. These diesels are providing dependable power in whatever service they are used.

BLW THE BALDWIN GROUP

BALDWIN DE LA VERGNE

SALES CORPORATION

SUBSIDIARY OF THE BALDWIN LOCOMOTIVE WORKS • PHILADELPHIA

Even though the required knowledge has been secured from a source other than formal schooling, it is customary to measure its possession in terms of equivalent schooling, which is the intent of the following point ratings.

Education Rating	Points
Grammar School Course	0-1
High School Course — knowledge of arithmetic, grammar, etc. (minimum requirements for office employes 2 points.)	1-2
High School Course plus additional training. Use 3 points for a high school course plus short specialized training in typing, blueprint reading, office machines, etc. Use 4 points for a high school course plus more intensive training covering a more involved field, such as secretarial, traffic clerk, etc.	3-4
High School, plus 2 yr. college or equivalent, comprising a specialized knowledge of a particular field, such as drafting, cost accounting, time study, etc.	5-6
College Graduate, knowledge of a broad technical field, as engineering, accounting and finance, chemistry, etc.	7-8
College Graduate plus post graduate work in a specialized eld	9-10

Standard Duties

This is an indication of the relative complexity of the duties to be performed considered as a whole, defined in terms of routine and non-routine operations. In a sense this factor attempts to describe in objective terms the total requirements of the position.

Relative Complexity	Points
Routine Duties—Same work each day or very simple duties.	0-1
Slightly Varied Duties of same general type	1-2
Varied Duties in type and importance	3-4
Duties Complex, requiring constructive thought and some independent judgment	5-6
Highly varied complex duties subject to constant change including responsibility and independent judgment	7-8
Unusual and difficult, varied work involving a high degree of responsibility and exercise of judgment	9-10

Supervision Exercised Over Others

Supervision Exercised	Points
None or very little	0-1
No actual supervision but must plan work to meet a schedule	1-2
Supervision of a small group but not responsible for methods or decisions. No actual supervision but some responsibility for methods or decisions of minor nature	3-4
Small amount of, or no actual supervision, but responsible for methods and decisions. Supervision of medium group of employes	5-6
Supervision of medium group of employes and responsible for methods and decisions. Small amount of, or no actual supervision, but responsible for involved methods and decisions. Supervision of large group, little responsibility for methods.	7-8
Supervision of large group of employes and responsible for methods and decisions	9-10

The sum of the ten basic factors provides a scale of 0 to 100 points for the measurement of job characteristics. While the restriction of space prevents a full reproduction of all factors, the others are rated in a similar manner.

Thus a certain type of job which is rated, let's say, 5 points for each of these ten factors would have a total job rating of 50 points.

Point Ratings Established

A special job description form was developed for the purpose of obtaining detailed information concerning the principal duties and responsibilities of each salaried job affected by the new plan.

A detailed description of his duties was, for the most part, filled in by the employe himself and later reviewed by the Department and Division Managers. After assembling the Job Description Forms, each Division Manager rated the jobs in his Division in the space provided for that purpose on the forms. Subsequently, the Salary Evaluation Committee reviewed these descriptions and graded each job independently to form a comparison with the total number of points assigned by the Division Manager.

After this had been completed for each job, a summary sheet was prepared and reviewed by all Division Managers and the full committee jointly for the purpose of agreeing upon the relative value of similar jobs common to all Divisions. After adjustments had been made, as recommended through this joint study, the point ratings were adopted as satisfactory for all Divisions.

Up to this time no reference had been made to the individual occupying the job, nor any use made of the actual salary at present paid for the job. Thus the rating was based upon the type of work performed, appraising its value in terms of a common point system that provided an equitable relative measurement among the 203 different jobs existing in the York organization.

Points Translated into Dollars

The next problem was to translate points into monetary values that would reflect the relative measurement now expressed in points alone, while at the same time approximating the present level of corporation salary roll requirements. To accomplish this, a graph was constructed of present salaries and points in a manner illustrated by the accompanying diagram. Upon this graph were plotted the 750 salary amounts on the lines corresponding to the point ratings assigned. Having done so an average line was drawn which became the preliminary "Evaluation Curve."

Having established relative salary averages for these jobs, a maximum was then established by the addition of 15 per cent to the average curve and a minimum by the deduction of 15 per cent from the average. Thereby each job was provided with a range of slightly more than 35 per cent above the minimum within which to recognize years of service and meritorious performance.

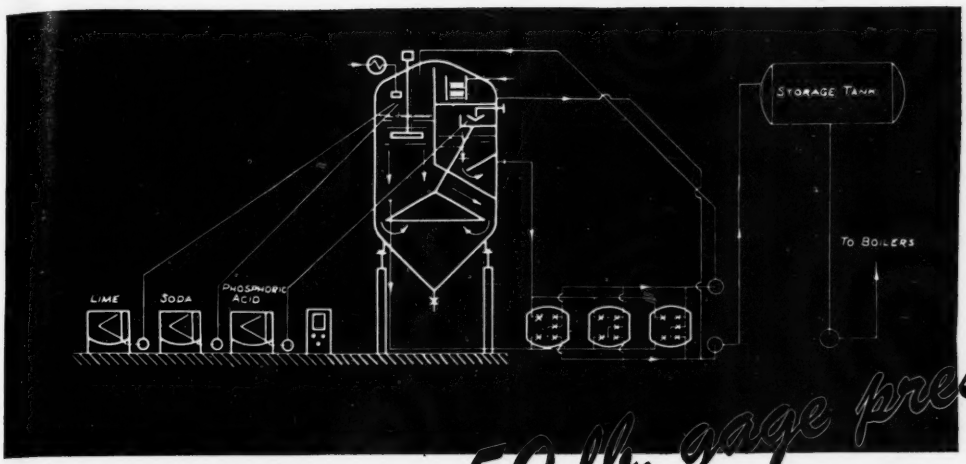
A minimum for all jobs was established at $60 per mo. for female employes and $70 for male employes regardless of the evaluation curve explained above.

Other Industries Compared

At this point there were selected for comparison with other industrial firms, seventeen representative jobs scattered throughout the various levels of the plan. Executives and Division Managers undertook to secure from the firms selected, a comparison of actual salaries paid for these seventeen positions.

Having secured this information, the resulting figures were adjusted among cities on a basis of the United States Bureau of Labor Statistics "Cost of Living Index" and plotted on a separate curve for comparison with the illustrated curve. This method was adopted to insure salary levels in line with those paid by other industrial firms. The final adjusted point evaluation curve was drawn using this procedure to determine the monetary value of the point system.

(*Continued on Page* 136)



Above is shown the arrangement of Cochrane Hot Process Softener for high pressure, high temperature system.

50 lb. gage pressure

298° F. temperature

COCHRANE HOT PROCESS SOFTENER OPERATING AT HIGH PRESSURE AND HIGH TEMPERATURE IMPROVES PERFORMANCE AND SAVES ON CHEMICALS

THE effectiveness of the hot process softener at high pressures and high temperatures is demonstrated in a recent Cochrane installation.

Whereas most hot process softeners operate at low pressures and seldom over 15 to 20 lb. gage, this softener is operating at 50 lb. gage, with an operating temperature of 298° F.

The chemicals used are lime and soda ash and phosphoric acid.

The installation has a softening capacity of 28,000 g p h of raw water and a capacity to heat and deaerate condensate at a rate of 16,000 g p h.

Softening is carried out in 2 stages. In the first stage the water is treated with lime and soda ash. Then it is decanted to a second compartment where it is deaerated and then treated with phosphoric acid to reduce the hardness and alkalinity remaining after the lime-soda ash process.

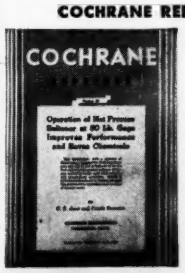
The final effluent is filtered, combined with the condensate and used as boiler feed without further treatment.

This has resulted in a high degree of hardness reduction and in economy of chemicals. Further details of this installation are incorporated in Cochrane Reprint No. 25. Write for a copy.

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia 32, Pa.

AVAILABLE FOR REFERENCE

COCHRANE REPRINT NO. 25



"OPERATION OF HOT PROCESS SOFTENER AT 50 LB. GAGE"

By Joos and Kemmer

A reprint of this story describing in detail the above installation. If interested, this reprint should be of considerable help in solving your own water conditioning problems. Write for a copy Use the coupon →

COCHRANE PUBLICATION NO. 4021

COCHRANE CARBITE (CARBONACEOUS ZEOLITE) SOFTENERS

A 16 page publication describing in considerable detail the Cochrane Carbonaceous Zeolite Softening Equipment, with typical analyses, diagrams and photos of installations. A copy will be mailed on request. →

Cochrane Corporation
3123 N. 17th Street
Philadelphia 32, Pa.

Check Please send me a copy of

☐ Cochrane Reprint No. 25
☐ Cochrane Publication No. 4021

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Firm ----------

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City ---------- State ----------

COCHRANE

HOT PROCESS SOFTENERS · DEAERATORS · BLOW-OFF SYSTEMS · FLOW METERS · SPECIALTIES

In every submarine, battleship, cruiser, plane and freighter, as well as in every plant manufacturing war products, there are valves. What would happen if any of these valves failed in an emergency?

Because Fairbanks Valves proved their dependability, efficiency and long life in pre-war work for more than half a century, thousands of them have already gone into war service.

You can "Bank on Fairbanks Valves". They are quality built through and through. Nothing is spared in the cost of materials and labor to make them as perfect as possible. Every part, as well as the finished valve, is carefully tested. Everything must be right before they are permitted to leave our factory.

Fairbanks Valves are made in bronze and iron, in types and sizes for practically every service.

Write for catalog No. 42 and name of our nearest distributor.

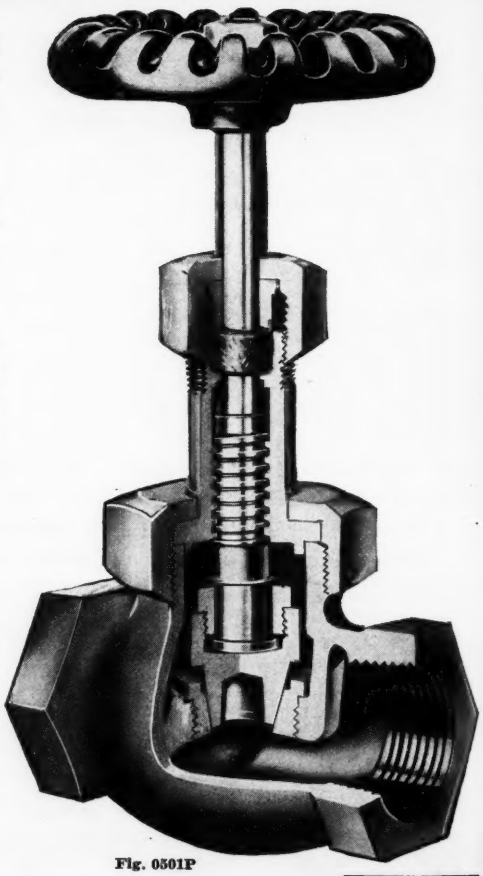


Fig. 0501P

THE FAIRBANKS COMPANY
393 Lafayette St. New York, N. Y.
Boston, Mass., Pittsburgh, Pa.
Distributors in Principal Cities

Fairbanks *Standard and* Renewable **Valves**

RIC-WIL FURNISHED MORE THAN 25,000 FT. OF PREFABRICATED INSULATED PIPE CONDUIT

For Terrace Village Housing Unit No. 2 in Pittsburgh

Fuel savings of 15% or better are made possible in this mammoth project by a central heating system. Ric-wiL pre-fabricated pipe units provide the insulation and protection for the entire underground distribution system.

Line of Ric-wiL conduit from anchor to boiler house (top, left). Note shallow, narrow trench.

Installing connector band. All necessary accessories are prefabricated and shipped with order.

A total of 83 buildings, comprising 1851 living suites, are supplied with heat and hot water from a central plant, through an underground distribution system containing over 25,000 lineal feet of Ric-wiL pre-sealed Insulated Pipe Units. High-pressure steam from the plant is piped through Ric-wiL steam conduit to six scattered stations where hot water is generated and circulated through Ric-wiL conduit to all the buildings, for heating and hot water supply. Thus the project realizes the economy of steam, and the temperature control and convenience of hot-water heating.

All conduit was factory pre-fabricated and shipped pre-sealed to the site in convenient lengths. Installation was made in record time, with a minimum of excavation and backfill, saving countless man-hours and interfering little or none with other construction. The system is highly efficient, permanent, and maintenance-free—typical of all Ric-wiL engineered projects.

Ric-wiL Insulated Pipe Units are ideal for hospital, school, industrial or municipal installations of all kinds. Let us show you their advantages on your next construction project.

RIC-WIL INSULATED PIPE CONDUIT SYSTEMS
THE RIC-WIL COMPANY · CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES

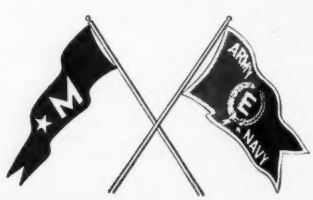
Fig. 1793—This large size 125 pound Iron Body Bronze Mounted Gate Valve has flanged ends, outside screw rising stem and taper wedge solid disc. Sizes, 2″ to 30″, inclusive. Also available with taper wedge double disc in sizes 2″ to 10″, inclusive (Fig. 1444).

Cradle of Industry— in the POWELL Line

Because the design of the Powell Valve Engineer is cradled into practical, serviceable reality by the skilled hands and practiced eye of the Powell Pattern Maker . . .

Because every POWELL Valve is nurtured from birth to installation by an almost century-old organization, whose business is making valves—and valves only—for Industry . . .

You buyers of valves are fully warranted in specifying POWELL Valves for all your flow control requirements, knowing that the POWELL name is your guaranty of pre-determined performance.



The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati, Ohio

POWELL VALVES

FREE TO WAR INDUSTRIES

To Help Increase Wartime Production, Cities Service Offers All Essential Industries A Free Industrial Heat Prover Test!

This test helps to solve combustion problems, reveals how fuel can be conserved, and the quantity and quality of the product increased.

Today, a vast majority of our industrial plants still are without any means of maintaining *accurate* combustion control.

It is to these plants that Cities Service Oil Companies now offer, *without charge or obligation*, a complete combustion control test with the unique, new Cities Service Industrial Heat Prover. This service is available on request in most of the important industrial cities East of the Rocky Mountains.

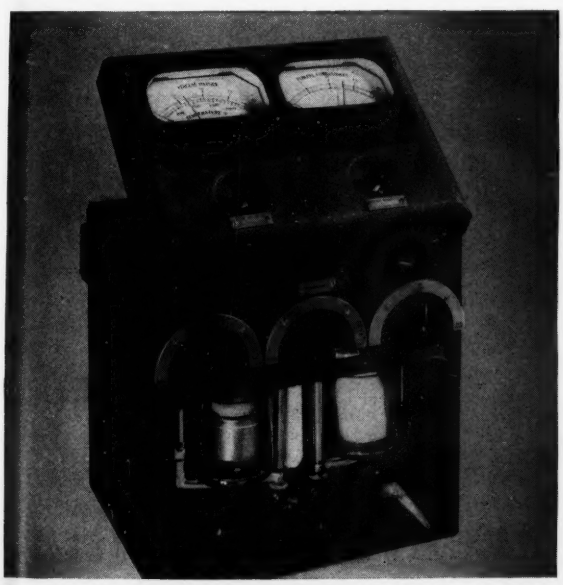
The Cities Service Industrial Heat Prover has been thoroughly tested on practically every type of combustion equipment in this country and with every kind of fuel.

It has been adopted by users of steam power plants, open hearth furnaces, cement kilns, heat-treating apparatus, crucible furnaces and internal combustion engines.

Accurate combustion analysis made as a result of the Cities Service Industrial Heat Prover tests have resulted in considerable savings in fuel costs, have reduced repairs and replacements on furnace linings, crucibles and refractories due to flame corrosion . . . and have led to increased production of better and more uniform products.

Wire or phone your nearest Cities Service office or mail the coupon today—for a Cities Service Industrial Heat Prover test in your plant.

A member of the Cities Service engineering staff will then visit your plant at your convenience and make a Heat Prover analysis of your combustion processes. This engineer has been carefully trained for the purpose, and has at his command extensive information gathered by the Cities Service Research Division from power, metallurgical and chemical fields.



THE CITIES SERVICE INDUSTRIAL HEAT PROVER—a new, accurate combustion analysis instrument—developed by the Cities Service Research Division to enable those engaged in the oxygen control of furnace atmospheres to achieve greater combustion efficiency at less cost.

CITIES SERVICE OIL COMPANY
Room 1678
Sixty Wall Tower, New York 5, N. Y.

Please arrange a Cities Service Industrial Heat Prover test for my plant. I understand there is no charge or obligation for this service.

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OIL IS AMMUNITION—USE IT WISELY!

CITIES SERVICE OIL COMPANY
NEW YORK · CHICAGO
IN THE SOUTH
ARKANSAS FUEL OIL COMPANY

GET THAT UNIT BACK

WHEN condenser trouble makes shut-down of a vitally needed unit imminent and unavoidable—it's *a job for specialists.* Call Conseco, and schedule a rush job — between peaks if possible.

In a short time after actual shut-down, with our special hydro-dynamic shock test, we can tell you how many bad tubes you have. If the number is small, and plugging will get you by for a reasonable length of time, we'll give you the good news and have you back in service *pronto.*

If the percentage of weak tubes is seriously high, we'll tell you that, too, and give you a report on what has to be done, and how *fast* we can do it — and we mean *FAST.*

Where retubing is found to be necessary, we can usually complete the job in one off-peak down — because we are specialists and because we have the know-how, the facilities and often the materials.

For fifteen years, now, we have been servicing condensers and heat exchangers for utilities and industrial power plants throughout the nation. During this time we have developed our own time-saving tools and methods to give you a better, faster job. Today we are operating on a clock-around schedule — *Emergency Service* is our normal business. Don't hesitate to call us any hour of the day or night.

Condenser Service
AND ENGINEERING CO., INC.

83 RIVER STREET, HOBOKEN, NEW JERSEY

★

NEW JERSEY TELEPHONE—HOBOKEN 3-4425

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NOW, a single book—indexed for easy reference—can take the place of separate handbooks and bulletins for identifying and ordering most G-E renewal parts needed to keep your equipment in operation. With this book, you'll find it easier to order genuine G-E parts *by catalog number*—saving time all along the line.

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Can You Answer These Questions ON VALVE SELECTION?

TODAY, when it is more important than ever before to keep pipe lines flowing at maximum efficiency, too much care cannot be given to selecting the right valve for each job. Before you "draft" a valve for that all-important line, make sure it is the one you really need.

Here are answers to two frequently asked questions on valve selection, taken from the files of The Kennedy Valve Manufacturing Co. Other problems will be considered in succeeding advertisements in this series.

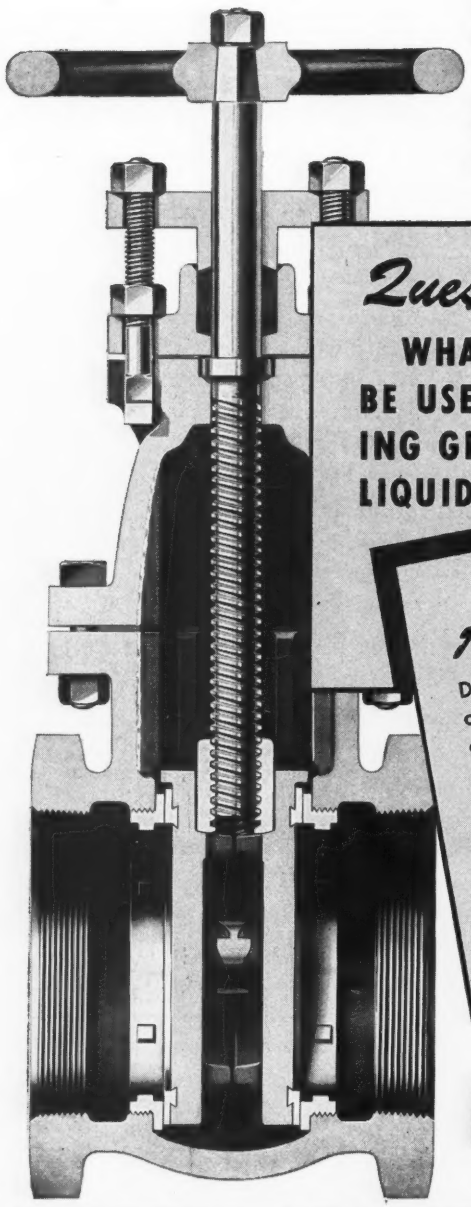


Fig. 2

Questions:

WHAT KIND OF VALVE SHOULD BE USED FOR LIQUIDS CONTAINING GRIT? FOR GUMMY LIQUIDS?

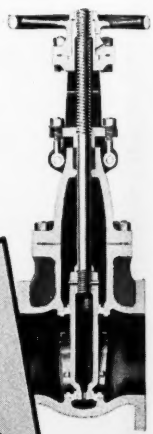


Fig. 1

Answers:

Double-disc gate valves (Fig. 2) are preferable where liquids containing grit are to be handled, because the flexibility of their operating mechanism enables one disc to seat tightly if grit is caught on the other seat, and also because the discs and seats are more readily refaced than those of wedge gate valves. Wedge gate valves (Fig. 1) are used where gummy liquids are handled, and are preferred for steam service by some engineers and operators.

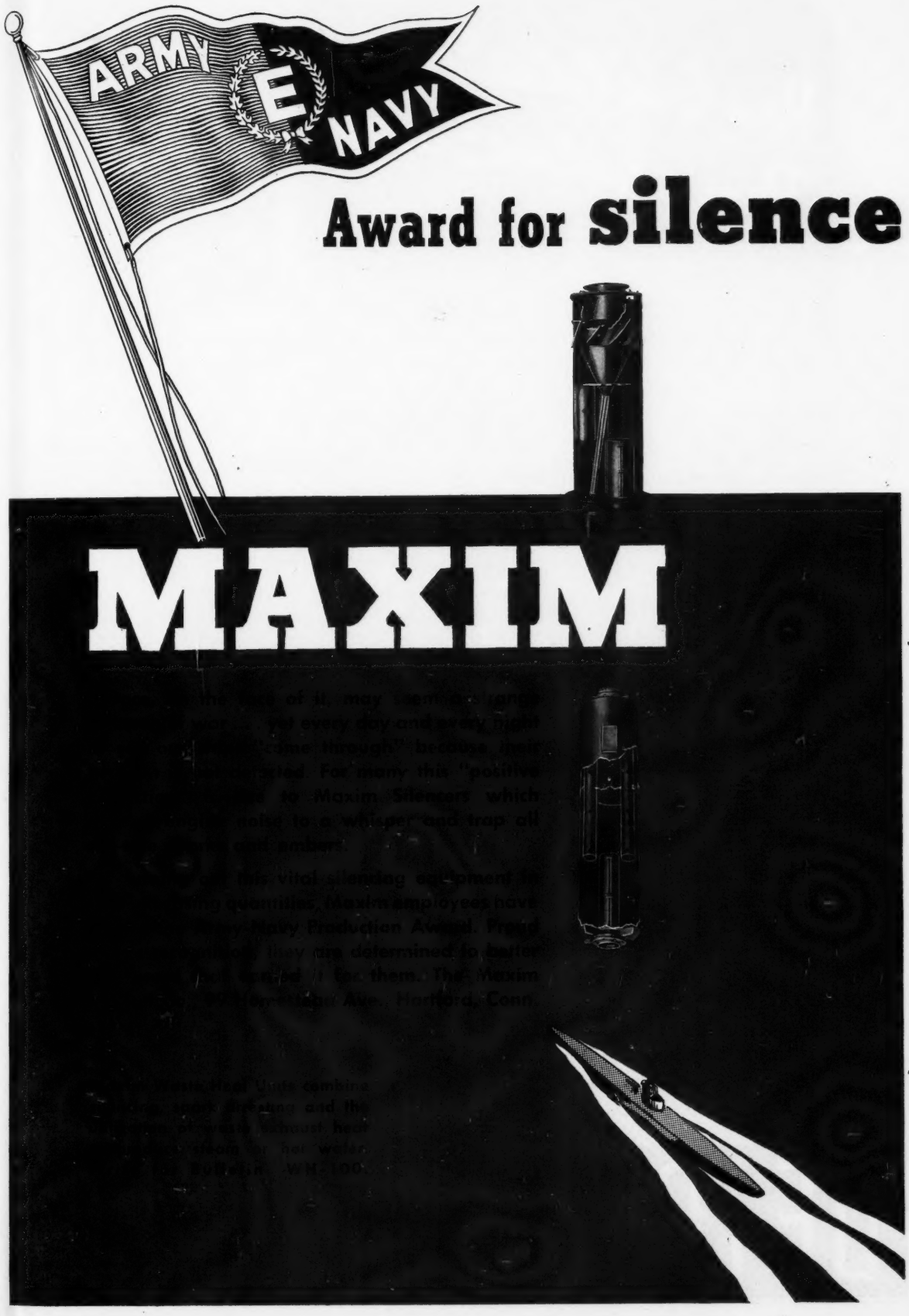
USE DOUBLE-DISC GATE VALVES FOR LIQUIDS CONTAINING GRIT . . . WEDGE GATE VALVES FOR GUMMY LIQUIDS.

If you have a valve selection problem, write to us. As Kennedy makes a complete line of standard gate, globe, angle and check valves, you can be sure of receiving unbiased help. For full description of Kennedy valves, pipe fittings and fire hydrants, send for 240-page Kennedy Catalog.

KENNEDY

VALVES • PIPE FITTINGS • FIRE HYDRANTS

THE KENNEDY VALVE MFG. CO. • ELMIRA, N.Y.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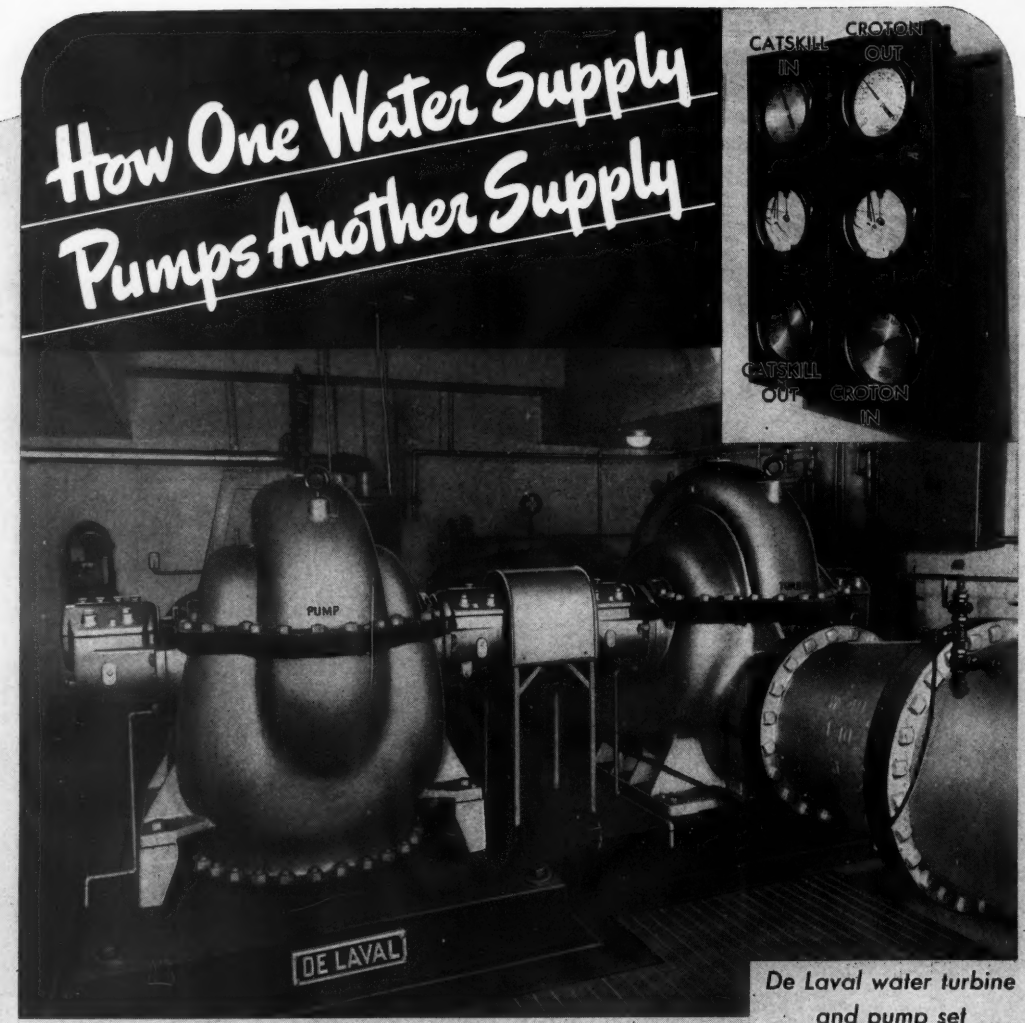
NAVY
Award for silence
MAXIM

How One Water Supply Pumps Another Supply



De Laval water turbine and pump set

The De Laval Water Turbine and Centrifugal Pump set here shown is located in a room beneath one corner of the Public Library, 40th St. and Fifth Avenue, New York City. At full capacity the water turbine, receiving 20,800 g. p. m. of Catskill water under 210 ft. head and discharging to its distribution system against 120 ft. head, drives a pump operating at 560 r. p. m., which delivers 21,000 g. p. m. of Croton water to its distribution system against 100 ft. head. The positive head at the suction nozzle is 35 ft. and 392 hp. is delivered by the water turbine.

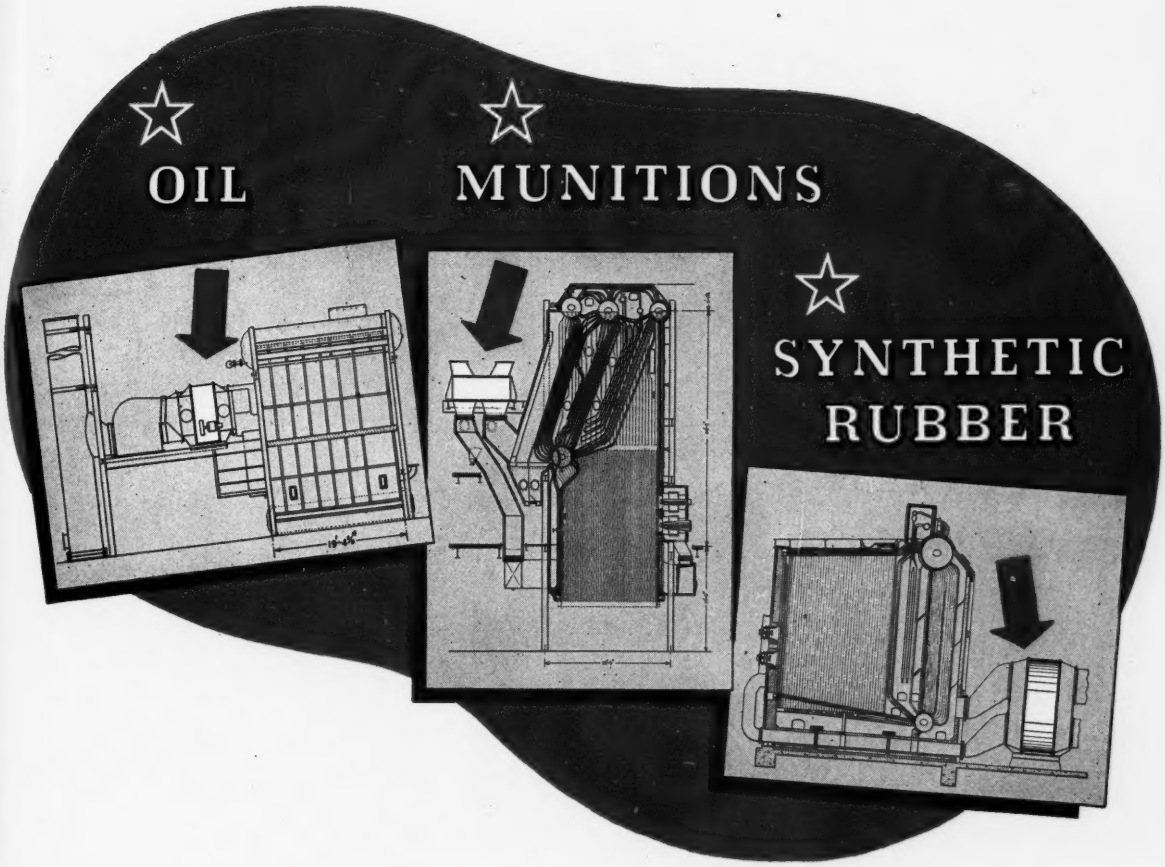
The speed of the unit is automatically regulated by a hydraulically operated throttle valve in the turbine discharge line, actuated by the pressure therein. No particular attention is necessary other than occasional inspection of the lubricating system.

De Laval engineers will gladly help in solving your pumping problems.

4107

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF TURBINES · STEAM, HYDRAULIC, PUMPS · CENTRIFUGAL, CLOGLESS, ROTARY, DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, PROPELLER, PRIMING SYSTEMS; CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS · WORM, HELICAL, and FLEXIBLE COUPLINGS



Vital war plants boost heat-recovery, save fuel, with Ljungstrom Air Preheaters

PROCESS industries at the heart of the war program are powered by Ljungstrom-equipped boiler plants. The reason? The Ljungstrom Air Preheater combines high operating continuity *with maximum conservation of fuel and steel.*

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With preheated air, combustion is more efficient, and poorer grades of fuel can be utilized. Waste-heat becomes an output booster.

In transferring heat from flue gases to incoming air, the Ljungstrom operates on a *continuous regenerative counterflow* principle that permits a reduction of ½ or more in the weight of heat transfer surface, compared to other types. Steel is saved, erection is simplified, and a higher heat-recovery level becomes practical despite today's limitations on construction materials.

In addition, the Ljungstrom has established high records for continuity of service, and normal maintenance is quickly and easily carried out. Gas temperatures as high as 1600°F are being successfully handled in installations in the process industries.

If you have a problem involving gas-to-air heat transfer, why not ask our engineers for application aid. On boiler plants, all major builders are prepared to incorporate the Ljungstrom in their designs.

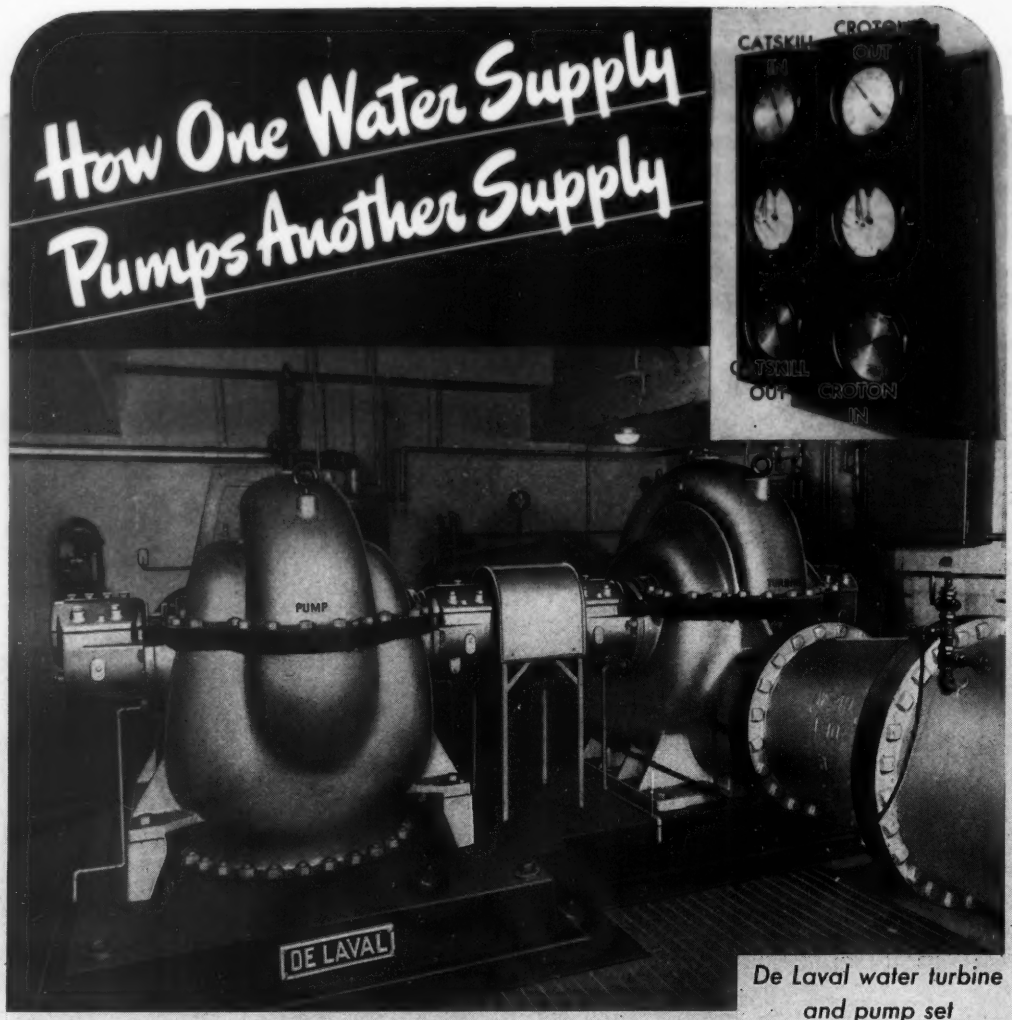
THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York, N. Y. • Plant: Wellsville, New York

How One Water Supply Pumps Another Supply



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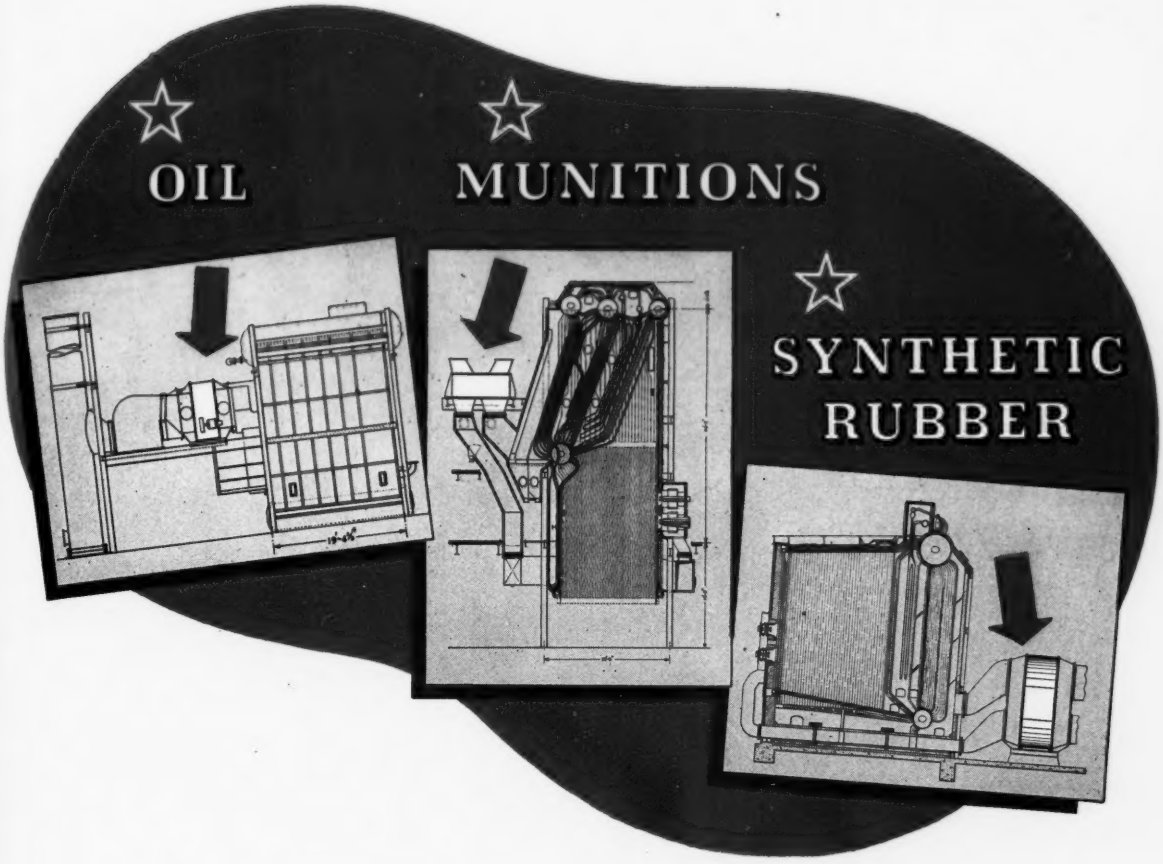
MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC PUMPS . . . CENTRIFUGAL, CLOGLESS, ROTARY DISPLACEMENT, MOTOR MOUNTED, MIXED FLOW, PROPELLER, PRIMING SYSTEMS, CENTRIFUGAL BLOWERS and COMPRESSORS GEARS . . . WORM, HELICAL and FLEXIBLE COUPLINGS



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• • • • •

With preheated air, combustion is more efficient, and poorer grades of fuel can be utilized. Waste-heat becomes an output booster.

In transferring heat from flue gases to incoming air, the Ljungstrom operates on a *continuous regenerative counterflow* principle that permits a reduction of ½ or more in the weight of heat transfer surface, compared to other types. Steel is saved, erection is simplified, and a higher heat-recovery level becomes practical despite today's limitations on construction materials.

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If you have a problem involving gas-to-air heat transfer, why not ask our engineers for application aid. On boiler plants, all major builders are prepared to incorporate the Ljungstrom in their designs.

THE

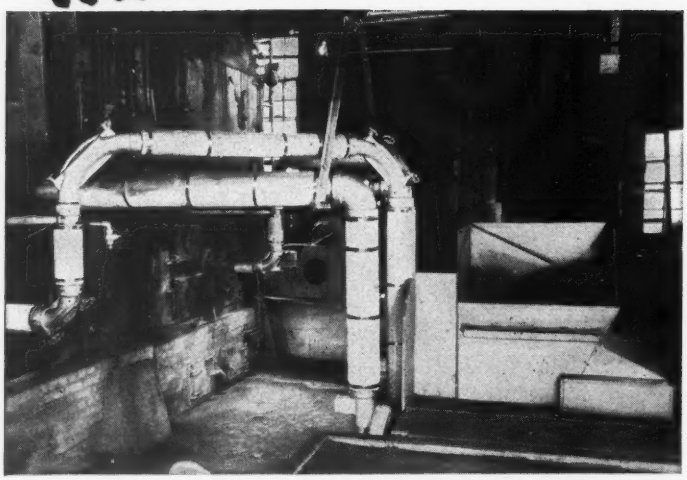
AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York, N. Y. • Plant: Wellsville, New York

IRON FIREMAN Uses a Ton Less Coal a Day - Handles 30% Load Increase

★ IRON FIREMAN Pneumatic Spreader Achieves Remarkable Results at the Giant Grip Manufacturing Company

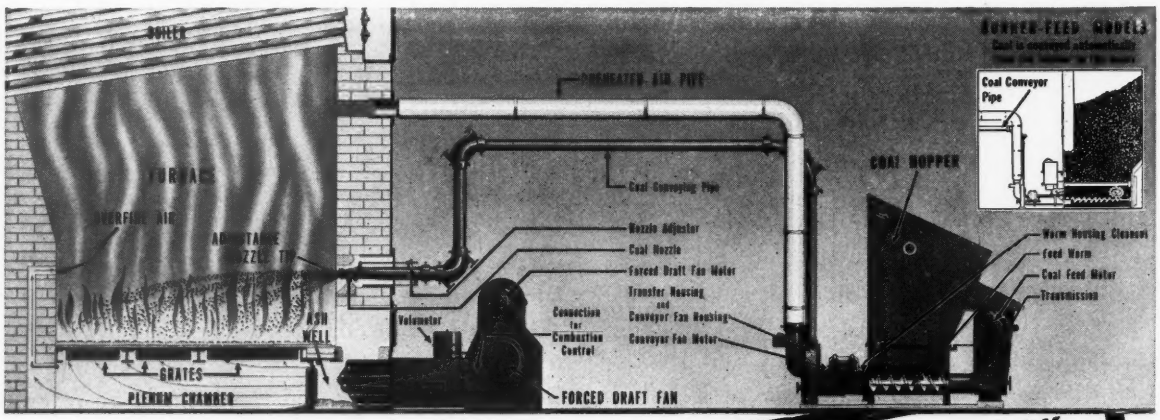


The Pneumatic Spreader at Giant Grip fires two HRT boilers—150 and 125 horsepower. Steam size coal is conveyed from the hopper to a transfer housing, where the coal is picked up by a stream of air and conveyed to the furnaces and grates. The fines burn in suspension, utilizing the conveying air for combustion. The larger pieces form a shallow fuel bed on the grate. By means of an adjustable nozzle, the coal is dropped by gravity and distributed uniformly over the entire grate surface. *At the back* is the under-grate forced draft fan unit. The auxiliary fan is mounted on the motor sheave for operation of the Volumeter, which adjusts the air supply according to the changing requirements of the fire bed.

TO back the navy 100%, the Giant Grip Manufacturing Company of Oshkosh, Wis., had to increase its steam load 25 to 30% without installing new boilers. The boilers could not carry this increased load with hand-firing, so a year ago an Iron Fireman Pneumatic Spreader automatic coal stoker was installed. Before the Iron Fireman installation was made three of the five steam hammers could not be used because of insufficient steam, but now the Pneumatic Spreader stoker keeps three large and two small steam hammers in full and efficient operation. Also, Giant Grip uses one less ton of coal per day than it did with hand-firing, even with this increased load and increased working hours.

John Crall, *Engineer* at Giant Grip Mfg. Co. for over 30 years.

Output of Iron Fireman commercial and industrial stokers has been substantially increased to equip heating and power plants converting from oil, hand-fired coal and gas. Our nationwide organization of qualified factory representatives and dealers is at your service. Iron Fireman Mfg. Co., Portland, Ore.; Cleveland; Toronto.



Send for FREE BOOK

Contains full descriptions, capacities, operating data, etc., with layouts and photos of 10 typical Pneumatic Spreader installations. Sent free, on request. Write for literature. Iron Fireman Manufacturing Co., 3518 W. 106th Street, Cleveland 11, Ohio.

IRON FIREMAN

Automatic Coal Stokers

ROUND-THE-CLOCK SERVICE ASSURED...

...by U.S.* in power plant's turbine!

"HOURS OF OPERATION" alone does not determine the quality of a turbine oil. More important are the characteristics of the oil during a given period. Did the oil need purification? Was make-up oil kept to the minimum? Did the system and the oil show rust? These are the sort of things that determine whether your turbine is operating economically, trouble-free.

One of the many outstanding performance records of Shell Turbo Oil is indicated in the analyses shown at the right. Note how little change took place even after 24,483 hours of continuous operation. Here is definite proof that Shell Turbo Oil has superior oxidation stability. It also prevents rust. Can the turbine oil you now use match this? Draw off a sample and see.

For details on this and other outstanding performances of Shell Turbo Oil see the Shell man. Or, write Shell Oil Company, Inc., Dept. "E," 50 W. 50th St., New York, N.Y., or 100 Bush St., San Francisco, Cal.

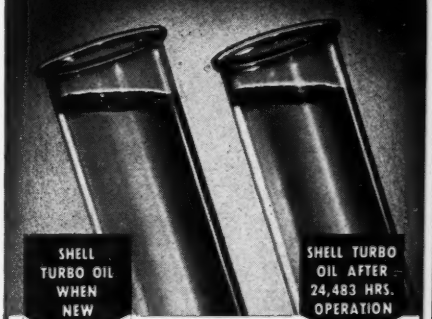
SHELL TURBO OIL

Currently, the U.S. Navy has first call on Shell's entire production of marine turbine oil

CERTIFIED PROOF OF THE SUPERIOR

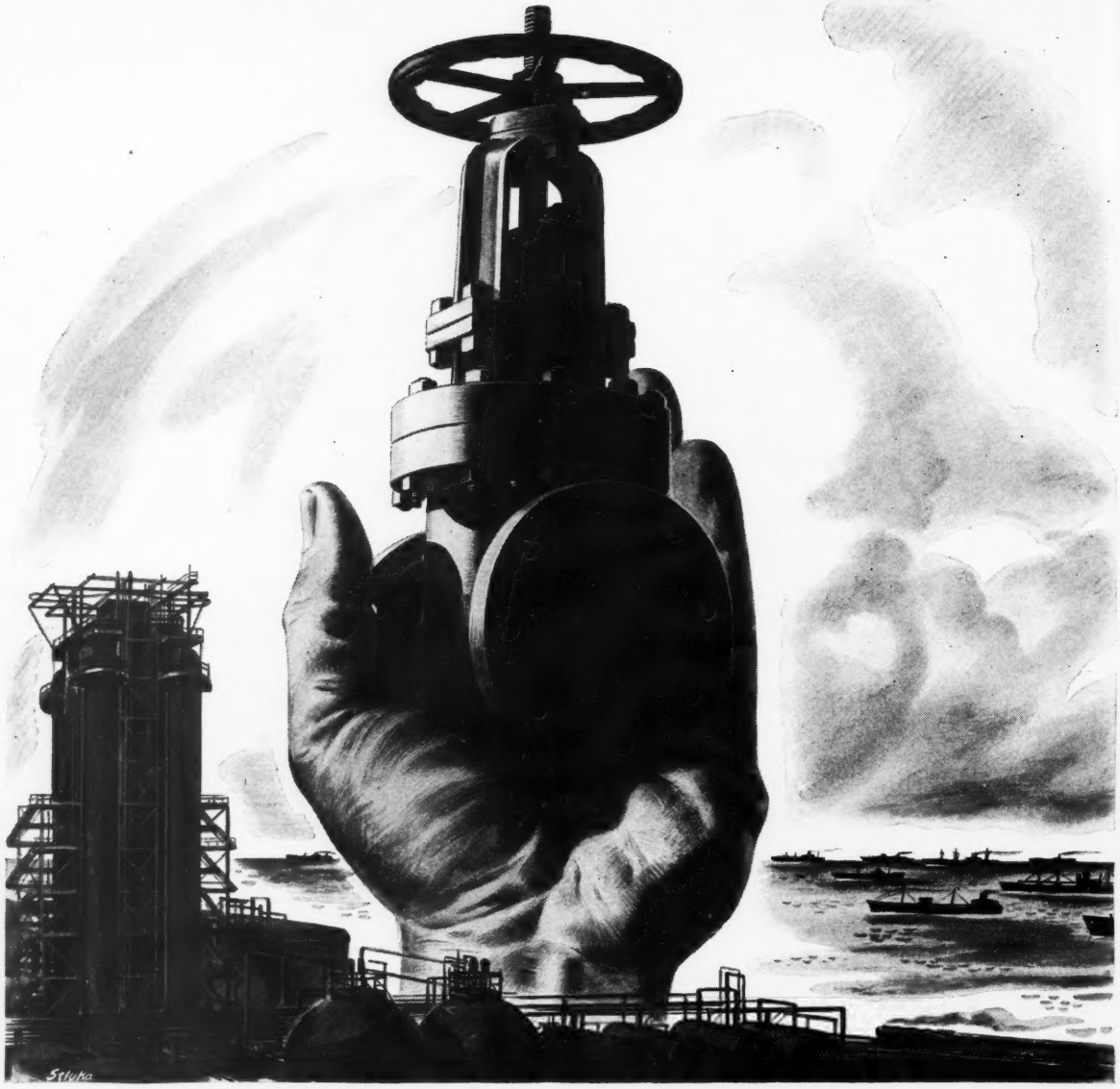
*OXIDATION STABILITY

OF SHELL TURBO OIL



CHARACTERISTICS		
156	*Viscosity @ 100° F.*	159
Clear	*Appearance*	Clear
.05	*Neutralization No.*	.05
.1	*Saponification No.*	.3

Performance record of Shell Turbo Oil in a 6,000 kw. unit of a large utility company in the Southwest.



CONTINUE TO "GUARD THOSE VALVES"

Since such tremendous tonnage must be carried to forces around the globe, it is easy to understand why Reading-Pratt & Cady for so long have advised you to "guard those valves." Ships are a maze of valves. ★ Strides toward victory should not encourage the thought that the transport of matériel for fighting Americans be put in jeopardy—so that we at home might have more. Now is the time to put into war every ounce of drive we can muster. Continue to guard your valves.

READING-PRATT & CADY

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READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
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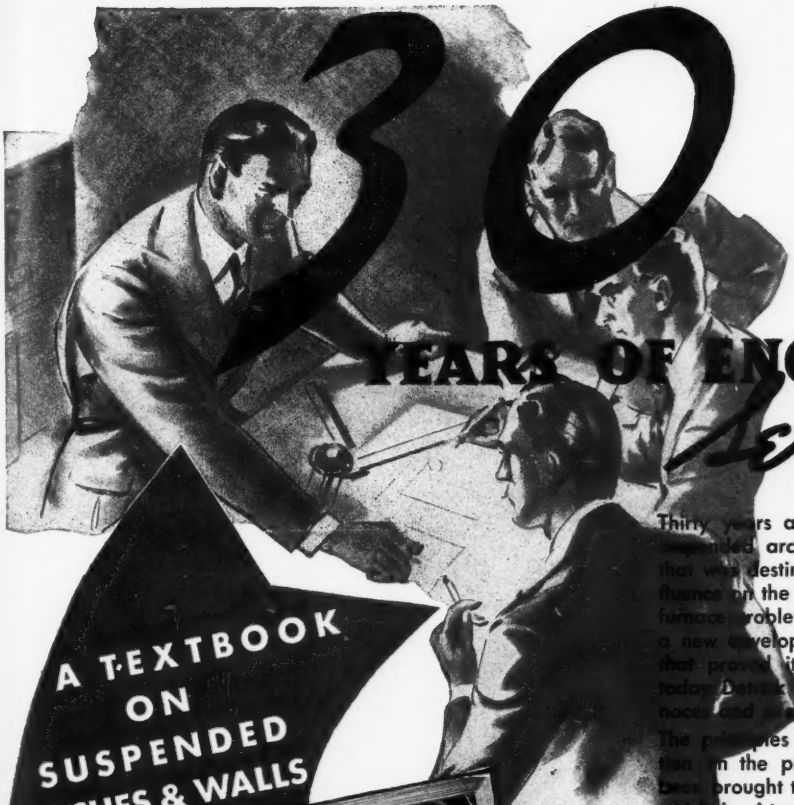
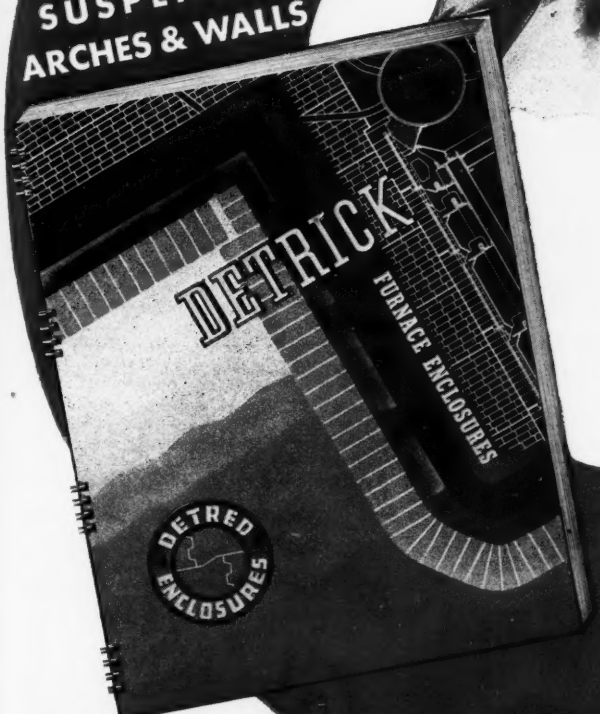
A DIVISION OF **AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT, CONNECTICUT**



30 YEARS OF ENGINEERING *Service*

A TEXTBOOK ON SUSPENDED ARCHES & WALLS



Thirty years ago when Detrick hung his first suspended arch he was pioneering in a field that was destined to have a very profound influence on the design of furnaces. As each new furnace problem presented itself Detrick offered a new development in suspended construction that proved its effectiveness in service. And today Detrick is designing for tomorrow's furnace and process units.

The principles learned in this long concentration on the problem of heat enclosure have been brought together in a new 80-page book which is virtually a text book on the subject of Enclosing and Conserving Heat.

A Textbook on Suspended Arches and Walls

Every engineer will find this book a quick way to bring himself up to date on this subject. The story is told in pictures and charts, illustrations and photographs, and the text explains the constructions and the reasons back of them.

Under such headings as those listed below the principles learned from thirty years of study and practical experience are presented in a graphic way that every engineer will appreciate.

Here Are a Few Titles:

Evolution of Furnaces, Detrick Arch and Wall Construction, The New Detred Refractory Tile, Detegral Insulated Wall, Thinsulite Walls, The Streamlined Construction, Boiler Walls, Casing Applied with a Trowel, Oil Still Furnaces, For Every Type of Steel Furnace, Detrick Refractory Hanger Construction, Air-Cooled Walls, Insulated Walls, Designing a Heat-Tight Wall, Detrick High-Temperature Insulation.

For those who have a problem in heat enclosure now . . . for those who contemplate such construction in the future, a copy of this new Detrick catalog is ready. Your copy will be sent on request, without obligation.

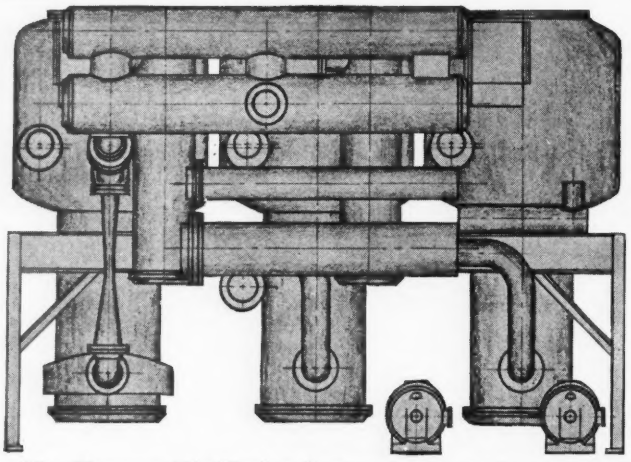
M. H. DETRICK COMPANY
140 South Dearborn Street • CHICAGO

DETRICK FURNACE ENCLOSURES

PURE WATER

Certain industrial processes require the use of large quantities of pure water. Boiler Plants need it for peak efficiency. For human consumption pure water is vitally important—to the folks on the home front as well as to the men on the fighting fronts.

While water is universally present, the available supply often contains certain objectionable salts and bacteria that make it unfit for immediate use.



The Henszey Distillation System is the modern method of assuring a plentiful supply of absolutely pure water—water that is free from objectionable salts and harmful bacteria. The Henszey unit gives six effect efficiency with only three evaporator effects. Pure water is made available with a saving of half the fuel necessary to get the same results by means of conventional distillation equipment.

If a supply of pure drinking water is your responsibility, if you need pure water in your plant or for your manufacturing processes—plan ahead now—investigate the Henszey Distillation System.

HENSZEY CO. Dept. C8 Watertown, Wis.

HENSZEY

CONTINUOUS BLOWDOWN SYSTEM

Boiler Feed Regulators • Proportioning Valves
Feed Water Meters • Flow Indicators • Heat Exchangers

A New Armature Winding Diagram

(*Continued from Page* 74)

QUESTIONS

(1) ... Using Fig. 2 write out the electrically identical coil-side positions of the 36-slot 27-coil layout corresponding to the 27-slot and coil winding.

Ans.

Poles	Phases (A)	(B)	(C)
1	1 x 2	3 z 4	5 y 6
2	7, 8, 9	10 x 11	12 z 13
3	14 y 15	16, 17, 18	19 x 20
4	21 z 22	23 y 24	25, 26, 27

(2) ... Fig. 2 shows that, below the ½-slot step certain slots are entirely (not partly) empty. Give the slot numbers and the phase-belts of the totally empty slots shown in Fig. 2.

Ans. In phase A the totally empty slots are 2 and 29; in phase B they are slots 5 and 14; in phase C they are slots 17 and 26.

(3) ... For a 60-slot, 54-active coil, 3-phase, 6-pole machine, how would you define the pole-pair phase class; what is the number of coils per pole-phase group; and what is the coincident-slot interval?

Ans. The class is *odd* coil *odd* phase and *odd* 2p (pole pair); number of coils per pole-phase group is $S/\emptyset p = 60/3 \times 6 = 60/18 = 3\text{-}1/3$; the coincident-slot interval is $S/(S\text{-}C) = 60/(60\text{-}54) = 60/6 = 10$.

(4) ... Assuming that voltage-unbalance permits, if the coil in slot 32 of phase B (Fig. 1) should burn out and no spare coil nor time for replacement be available, what would you suggest as the best temporary connection to give satisfactory operation assuming the winding to be a 3-phase induction motor with single-series, star-connected stator?

Ans. Merely disconnect this coil from the winding and join the lead from slot 4 to that from slot 33 thus "jumping" slot 32. (Note that this form of diagram has the advantage of visualizing these and such like winding connections.)

(5) ... Give the "empty" slot or dead coil-side intervals, number of coils per pole and phase, the order of coil grouping, and the coil-phase-2p class of the following unequally-grouped-coil phase-windings.

(a) 48-slot 45-coil 3-phase 4-pole layout
(b) 72-slot 60-coil 6-phase 8-pole layout
(c) 60-slot 54-coil 3-phase 10-pole layout
(d) 84-slot 78-coil 2-phase 6-pole layout

Ans.

Layout	S/Op	S/(S-C)	Class of winding
(a)	3¾	16	*odd* coil *odd* phase *even* 2p
(b)	1¼	6	*even* coil *even* phase *even* 2p
(c)	1.8	10	*even* coil *odd* phase *odd* 2p
(d)	6½	21	*even* coil *even* phase *odd* 2p

Order of coil grouping is

(a) 3 4 4 4 3 4 4 4 3 4 4 4
A B C A *B* C A B *C* A B C

(b) 2 3 2 3 2 3 2 3 2 3 2 3
A B *C* A *B* C *A* B *C* A *B* C
(Repeat for the other three phases and four poles)

(c) 1 2 2 2 2 1 2 2 2 2 1 2 2 2 2
A B C A B *C* A B C A *B* C A B C
(Repeat for the same phases and the other five poles)

(d) 6 7 7 6 7 7 6 7 7 6 7 7
A B A *B* A B *A* B A *B* A B

NOTE: Without the use of mathematics a simple skeleton diagram of each layout (a) to (d) give the correct electrically identical coil-sides and phase-lead postions as well as their electrical angular values and relations.

Was YOUR Plant Heated Comfortably last Winter?

One of a number of large defense plants whose workers were comfortable and therefore more efficient all last winter. Were yours?

THE well-being and health of factory workers will be more important this coming winter than at any time since the beginning of the war. You may remember the complaints you had about cold working quarters last winter. Don't take chances again. Investigate Wing Revolving Unit Heaters, used by many of the country's leading manufacturers who recognize the importance of employee comfort and satisfaction. The gentle air motion created by the constantly changing direction of a WING Revolving Unit Heater brings a sensation of fresh, live, invigorating warmth to workmen, increasing their sense of comfort and promoting health and efficiency. Write today for a copy of Bulletin HR-2.

L. J. Wing Mfg. Co.

7th Ave. & W. 14th St. New York City
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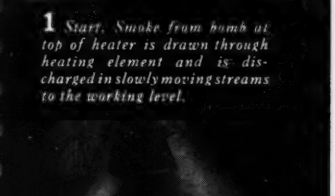
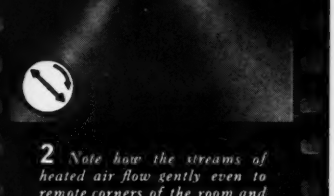
WING TIPS:
The wise executive will order Revolving Unit Heaters NOW. September may be too late.

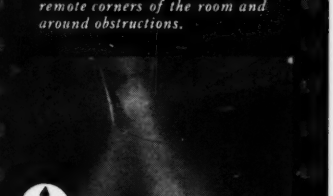
1 *Start. Smoke from bomb at top of heater is drawn through heating element and is discharged in slowly moving streams to the working level.*



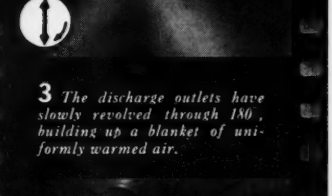
2 *Note how the streams of heated air flow gently even to remote corners of the room and around obstructions.*



3 *The discharge outlets have slowly revolved through 180°, building up a blanket of uniformly warmed air.*



4 *Still turning through 270° the streams of heated air are covering every part of the working level.*



5 *The discharge outlets have completed one revolution, demonstrating conclusively the thorough coverage of the WING Revolving Heater.*

WING *Revolving* UNIT HEATERS

These Frahm Resonant-Reed Tachometers have taken a beating. Designed for permanent mounting, they have been used as portable instruments, continuously for 22 years, on the test floor of a turbine manufacturer. When returned to us for repair and recalibration we found that, except for one reed which had been broken, no reed registered more than 2% out of calibration and nearly all were correct within 1%. The instruments have been repaired and are now back in the same hard service.

Frahm Resonant-Reed Tachometers are simple and rugged in construction . . . accurate and dependable in operation. With no parts to wear, adjust, lubricate or renew they give years of trouble-free service. Built in types for permanent mounting, and for hand use in servicing, testing, installation and maintenance work. Various ranges available from 900 to 30,000 R.P.M.

For a complete description of the Frahm Tachometer together with list of types and ranges commonly supplied, write for Bulletin 1590PE.

The same instruments shown above, after repair and recalibration in the Biddle Repair Department.

JAMES G. BIDDLE CO. • 1211-13 ARCH STREET PHILADELPHIA, PENNA.

Job Evaluation

(*Continued from Page* 118)

Advantages

The principal purposes and advantages of the plan are:

A—To provide a measuring stick of job values for individual jobs relative to all other jobs in the corporation's salary group.

B—To gain an equitable and comparatively uniform recognition of job values throughout all Divisions of the corporation.

C—To provide a regularly recognized scale of advancement from simple to complex jobs.

D—To minimize under or over payment for the types of services rendered.

E—To stimulate advancement.

F—To facilitate comparison of rates paid by other industries for similar jobs.

G—To supply the Management with an accurate detailed description of the experience and training required for various jobs, thereby improving original selection and subsequent training.

H—To minimize the turnover in jobs where training is costly.

These benefits accrue, either directly or indirectly, to both the employe and the company. To the extent that they improve the confidence of each in the other, a definite gain is achieved beyond any salary control procedure having no definitely outlined method of appraisal.

In the adoption of such a procedure for the control of salary rates, it is recognized that time will be required to adjust all of the situations not previously in line with the plan. It is the intention that this shall be accomplished gradually with a minimum of abrupt changes. It is hoped that with a definite scale of relative measurement, all employes will put forth a genuine effort to improve their knowledge of their own assignments and those to which their present positions may logically lead. Such improvement will form a preparation for advancement to jobs of higher grade and promote the welfare of the individual and the company.

FROM the Office of War Information comes the statement that labor grievances are coming before the National War Labor Board at a rate that is greatly overtaxing it. In the week ending June 25, 141 dispute cases were referred to regional offices of the Board. On that date the Board had a backlog of 1564 disputes awaiting settlement.

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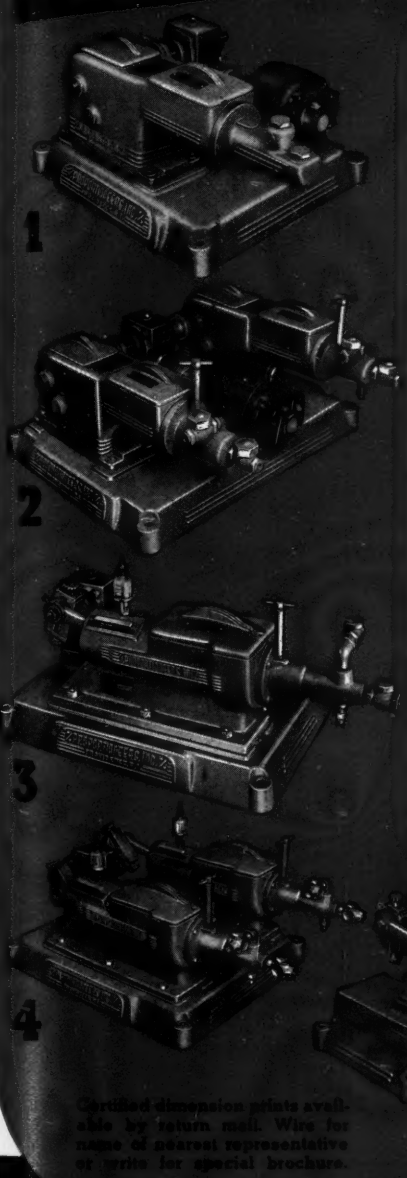
CHEMICAL PROPORTIONING PUMPS
for the Power Plant

Get positive protection against scale, corrosion and embrittlement with Heavy Duty Adjust-O-Feeder Proportioning Pumps for phosphates, sulphites, sulphates, water treating chemicals and prepared compounds.



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  Up to 7.5 g.p.h. 1,000 p.s.i.g.
- **MODEL 1XD** ***Midget Series Duplex Adjust-O-Feeder***
  Up to 15 g.p.h. 1,000 p.s.i.g.
- **MODEL 2XS** ***Standard Simplex Adjust-O-Feeder***
  Up to 42 g.p.h. 500 p.s.i.g.
- **MODEL 2XD** ***Standard Duplex Adjust-O-Feeder***
  Up to 84 g.p.h. 500 p.s.i.g.
- **MODEL 2XS** ***High Pressure Simplex Adjust-O-Feeder***
  Up to 50 g.p.h. 3,000 p.s.i.g.
- **MODEL 3XD** ***High Pressure Duplex Adjust-O-Feeder***
  Up to 100 g.p.h. 3,000 p.s.i.g.

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FEATURES — MICROMETER stroke adjustment, FLUID-SEALED plunger and stuffing gland, needle bearings, visible capacity scales, long cross-head guides, interchangeable disc or built-in ball check valves. Each pump tested under job conditions. Certified calibration curves with each unit.

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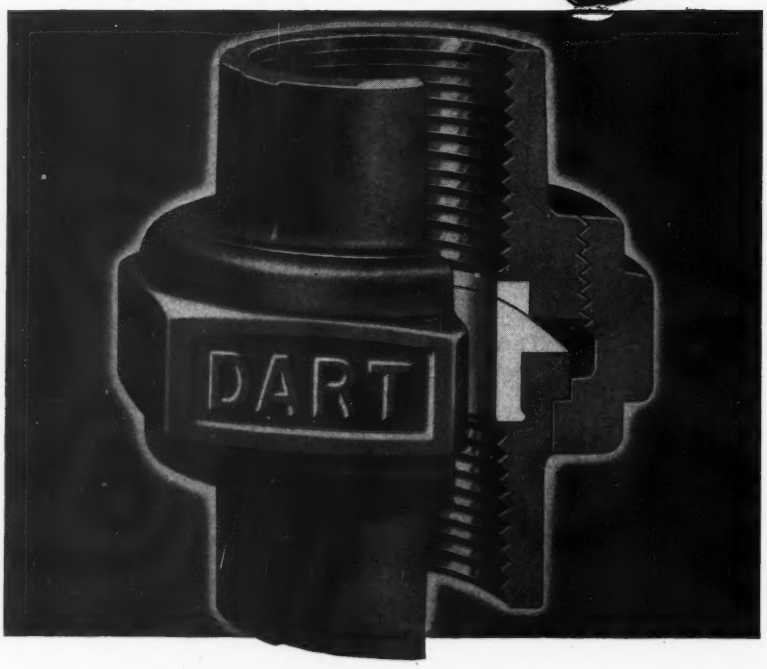
TEAM UP

Your Old DART UNIONS with New Ones



. . . For Used Darts Can Be Put Back To Work

Here's a well-proven formula for conserving vital metals and helping to win the production war. ***Search out the old Dart Unions around your plant and put them back on the job with new ones*** **. . . for, old and new Darts work swell together.**

You see, "old-time" Darts will make up tight quickly . . . and ***stay*** **tight—like new Darts. And here's the explanation of** ***why*** **Darts can be used so many times with complete satisfaction: matched bronze seats, ground to "true-ball" surfaces; High Test Air Refined Malleable Iron Nuts and Bodies that resist pipe strains and rough handling.**

So, if you have any idle ***used*** **Darts, put them back to work. And if you need new Darts, see your supplier.**

DART UNIONS

E. M. DART MANUFACTURING CO., PROVIDENCE, R. I.

NDHA Hears Reports of Technical Committees

FOLLOWING its traditional custom, the 34th Annual Meeting of the National District Heating Association held in Hotel Schenley in Pittsburgh June 9 and 10 was devoted to the presentation and discussion of committee reports supplemented by papers of special interest to committee members. The meeting was planned to be strictly a technical meeting for the consideration of war time problems confronting steam utility companies.

While much of the meeting was concerned with business activities such as rates and regulations, sales development, and commercial relations, many helpful ideas on engineering practice were brought out in the reports and discussions of the committees dealing with research, chemistry, steam station engineering and steam distribution.

It was revealed that the Association is making distinct progress in its studies of the basis of comparison for heat used in different types of buildings in different cities, and progress was also reported on weather statistics. In one report, the committee pointed to some unusual uses of steam and condensate which called for special study but indicated that steam from central stations has a field of application which is continuously widening.

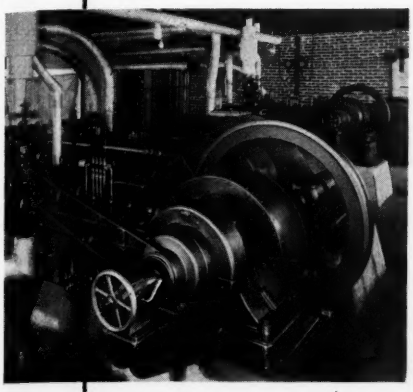
The dissolution of CO_2 in steam heating equipment was reported as undergoing study and the activities of the American Coordinating Committee on Corrosion were outlined. Among the Association's specific contributions was a study of prevention of corrosion in banked and stand-by boilers.

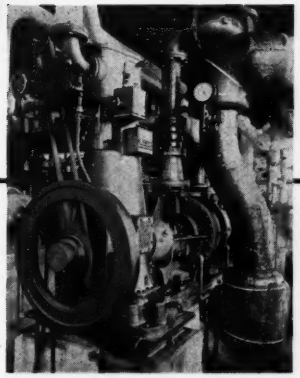
In a number of the reports, war time problems were discussed such as the unusual meter maintenance due to war conditions, personnel problems, bombing possibilities in the United States, spare capacity during the war emergency, war time conservation of critical materials in constructing underground steam lines, and plans for distribution system protection and operation in event of air raids or other war incidents.

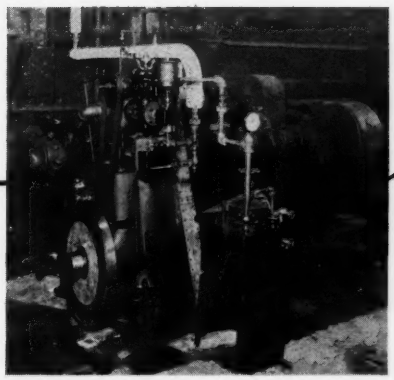
Principles for the safe storage of coal were discussed by the Steam Station Engineering Committee, and difficulties encountered with distribution piping systems that have undergone flood conditions were reported and discussed by the Distribution Committee.

POWER + HEAT

You Can Get BOTH From Steam







USE "BY-PRODUCT" POWER TO DRIVE

Stokers

Blowers

Fans

Generators

Compressors

Pumps

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"That's elementary", you say. It is, but it is also surprising the number of plants that are throwing away dollars by generating and using steam for processing without harnessing the "by-product" power in that steam. USE THE POWER IN THE STEAM FIRST—and then use the heat units.

When heat balances are right, Troy-Engberg Steam Engines will extract the "by-product" power at a lower cost than any other power unit. Many installations prove that the steam engine effects large savings, usually enough to pay for the engine cost in one or two years. And along with its low power cost, the modern steam engine provides a wide speed range and great flexibility; high-starting torque and sustained overload capacity; freedom from fire hazard; and under certain conditions, oil-free exhaust.

The Troy-Engberg Steam Engine is for many plants the best drive.

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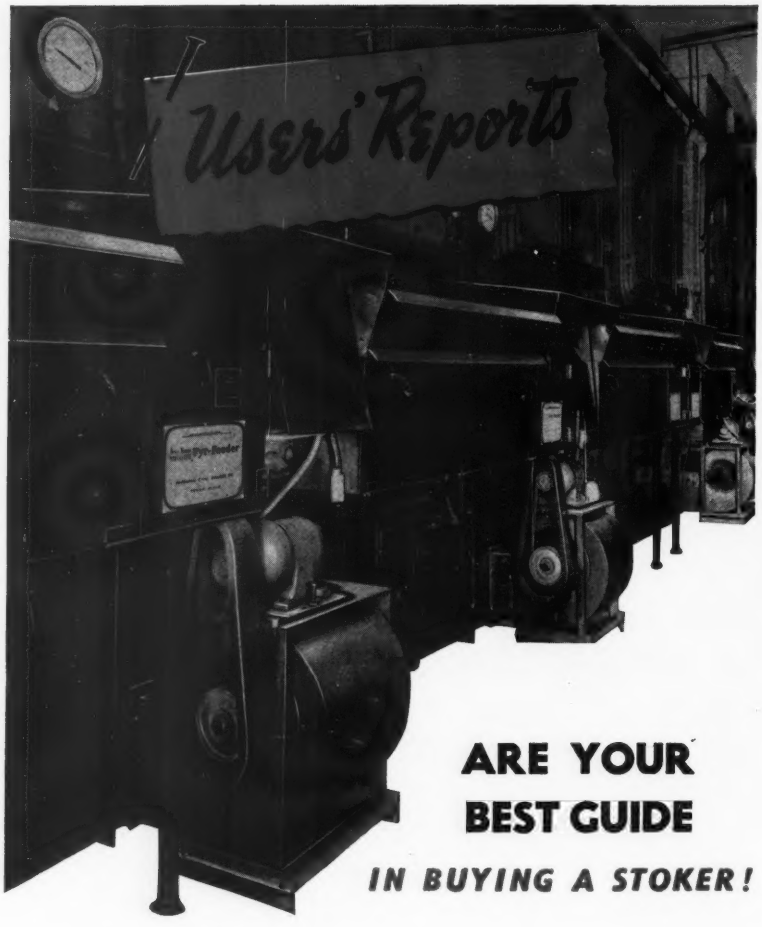

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These and similar case studies are your best guide in buying a stoker, whether to improve your coal firing or on a changeover from oil to coal.

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Describes FYR-FEEDER operating principle and exclusive design features. Tells how FYR-FEEDER burns coal like oil and burns any coal. Write now.

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ENGINEERS • ESTABLISHED 1918

Builders of thousands of Industrial Stokers

22-18 E. Erie St. Chicago 11, Illinois

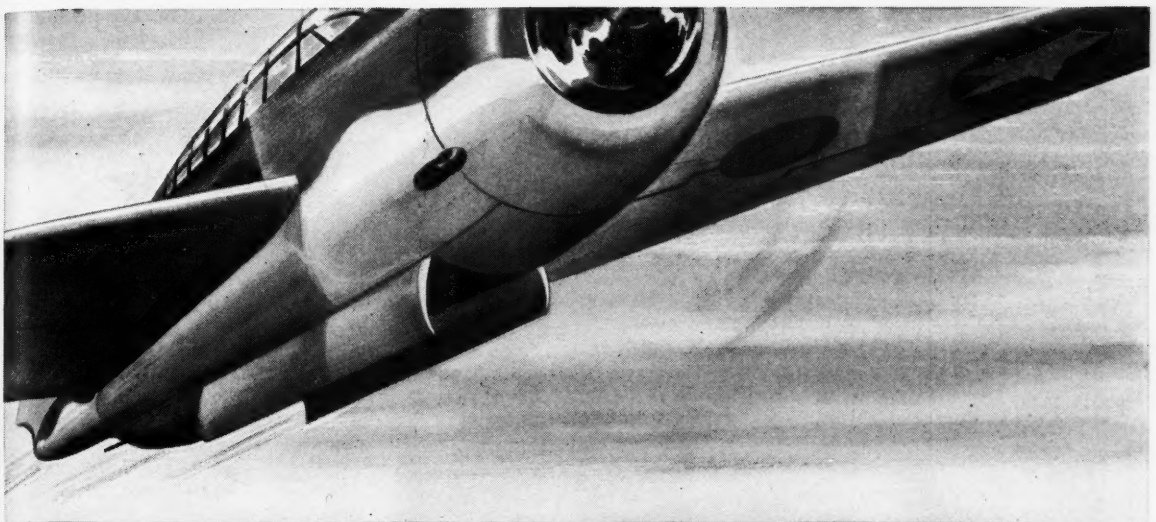
The newly elected officers of the Association are: J. J. Schenk, president; Sterling S. Sanford, first vice-president; Ray M. McGuitty, second vice-president; John F. Malone, third vice-president; on the executive committee are ex-president William A. Herr, L. C. Killen, and Robt. D. Martin.

SPA Convention at Pittsburgh

FOR THIRTY-SEVEN years the Smoke Prevention Association of America has been fighting the air pollution of our cities by the most logical methods known to the engineering, psychological and legal professions. Engineers have demonstrated that all types of fuels can be burned for useful purposes without the emission of objectionable smoke. Educational methods have been used extensively to inform fuel users how to burn available fuels in various types of furnaces at highest efficiencies and without producing smoke. Legal means have been provided to be used by city authorities to force offenders to employ proper equipment and methods to burn fuel without smoke. These fundamental principles were all brought out clearly at the convention held in Pittsburgh on June 8 to 11.

At the opening session President Arthur E. Hutchinson introduced Mayor Scully who outlined the legal mechanism which Pittsburgh has been using to clear the atmosphere of objectionable smoke. A. L. Wolk, Pittsburgh councilman and chairman of the committee responsible for the new Pittsburgh smoke ordinance, explained methods employed to secure cooperation of citizens in preventing smoke. M. Jay Ream, representing the Civic Club of Allegheny County, outlined the efforts his organization has made to see that various sections of the community reduce to a minimum their contribution to the smoke nuisance.

These addresses were followed by papers dealing with the more specific problems of fuels and their conservation. An analysis of the present and future fuel oil outlook and the problem of conversion of furnaces from oil to coal burning were treated by A. B. Wolle. The petroleum industry's viewpoint of the fuel situation was explained by R. J. Boyink of the Standard Oil Co., who pointed out how the industry is making every effort possible by means of pipe lines, tank cars, trucks and other means to supply oil to those in need of this



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Less than 20 ft. long, weighing approximately a ton, the deadly giant "tin fish" torpedo can blast a $60,000,000 battleship into jumbled scrap. . . . Within its cylindrical steel walls are 5,222 parts — 1225 different assemblies — for propulsion, navigation and destruction. . . . Some parts are machined to dimensions so close that their lubrication is accomplished with a medical hypodermic needle. . . . Seamless steel tubular parts for these most complicated and deadly devices of warfare are produced at Globe Steel Tubes. . . . Globe ability to produce steel tubes of exacting characteristics is effectively helping to perfect this most complicated device of destruction.

We salute the fighting courage of the torpedo plane squadrons who so skillfully drop "tin-fish" from the sky to hasten Allied Victory.

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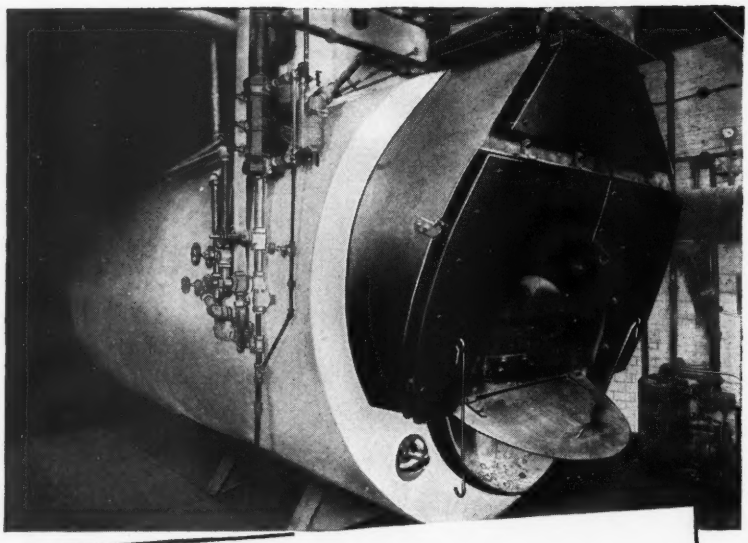
1101

GLOBE STEEL TUBES CO., *Milwaukee, Wisconsin, U.S.A.*



125-hp. Scotch Marine Boiler in which steam pressure is maintained at 125 lbs. at a temperature of 350° F. Heat losses were substantially reduced by application of B-H *Black* Rock-Wool Blankets 2" thick and finished with ½" coat of B-H No. 1 Insulating Cement.

FOR INSULATING EFFICIENCY

AND LOW-COST APPLICATION

YOU CAN'T BEAT

B·H ROCK·WOOL BLANKETS

Baldwin-Hill Blankets are made by felting B-H *Black* Rock-Wool into large flat sheets between 4 different styles of metal fabrics. This B-H *Black* Rock-Wool is effective up to 1200° F. and is moisture-resistant. Standard blanket sizes of 2'x4' or 2'x8' make possible applications to large areas at minimal cost. Being flexible, they do not break in handling and easily conform to curved surfaces.

If a cement finish is desired, style 2A Blanket includes expanded metal lath making a good surface for keying the cement. This eliminates the necessity of applying a metal fabric to hold the cement as must be done in covering other types of insulation.

Send for catalog with full information and a generous sample of B-H Rock-Wool Blanket.

BALDWIN-HILL BH INSULATIONS

BALDWIN-HILL COMPANY

577 KLAGG AVE. • TRENTON, N. J.

NEW YORK • CHICAGO • KALAMAZOO

fuel. In discussing war time fuel conservation, K. C. Richmond, editor of Coal-Heat Magazine, urged users to keep their heating plants clean throughout, to put them in repair and adjustment for the available fuel, and suggested that wood may be used advantageously in some instances as a supplementary fuel.

Overfire Air

Among the papers presented at the conference of particular interest to power plant engineers was one entitled Overfire Air Performance Applied to Stationary Plants by H. C. Carroll of Commercial Testing and Engineering Co. His paper will be published in a later issue of this magazine but for this report it may be said that he outlined the necessity of a careful investigation of conditions surrounding the operation of furnaces that have been or will be compelled to change the type of fuel for which the furnace was designed. He dealt specifically with hand firing, single and multiple retort stokers, chain grates, and overthrow stokers. He stated among his conclusions that the flame travel in furnaces can be shortened to the desired point in most cases by the application of overfire air.

Other papers containing data of value to combustion engineers were presented by H. F. Hebley on the chances of error in sampling coal, by Dr. H. J. Rose on the smoke tendencies in coals of various ranks, by K. H. Bowman on the collection and disposal of fly ash from spreader stokers, by H. C. Dohrman on the analysis of fly ash, by C. F. Hardy who gave a review of surveys of heating and power plants in various cities with recommendations for smoke elimination, by R. B. Engdahl on the design and application of overfire air jets, and by B. H. Whitehouse on the burning of wood waste in power plant boiler furnace.

In addition to the papers enumerated above, several others were devoted to locomotive practice and work being done by smoke inspectors to determine the degree of air pollution in various cities.

Officers chosen for the coming year are: Arthur E. Hutchinson, president; W. E. E. Koepler, first vice-president; John E. Cooney, second vice-president; Frank A. Chambers, secretary-treasurer; and W. H. Demsey, sergeant-at-arms.

WeldELLS have everything ★

"For MY KIND of work, give me WeldELLS"

THIS maintenance job is a tough spot in anybody's language. But the piping end of it would be a bed of roses if all the lines were welded with WeldELLS!*

Give me a good man with a torch, and a stock of WeldELLS, and I'll show you how to lick those quick changes that come up these days, too. WeldELLS have everything it takes to speed up the job and cut the costs—tangents that make them easy to line up; quarter-markings to guide the work; clean bevels and lands that make welding both good and fast. You don't have to grope for the proper size either, because the size and weight is marked right there on the fitting.

When the job is done with WeldELLS it's done for keeps. There's no tinkering or trouble shooting. For my kind of work, give me WeldELLS!

★ No other fittings for pipe welding combine these features found in WeldELLS:

- **Seamless** — greater strength and uniformity.
- **Tangents** — keep weld away from zone of highest stress — simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement**—provides uniform strength.
- **Permanent and complete identification marking** — saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum** — assures full strength and long life.
- **Machine tool beveled ends** — provide best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485

WeldELLS are just one of many Taylor Forge products that are vital to war and victory. An example is huge rolled steel rings—an important part of U.S. tanks now in action.

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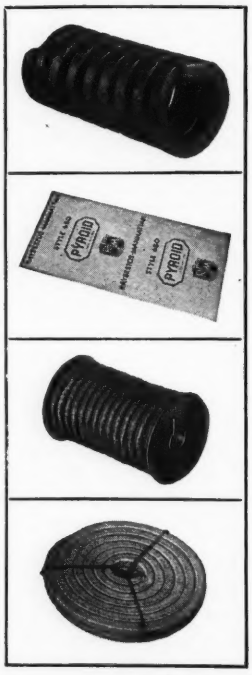
* WeldELLS and many other Taylor Forge products are produced in Byers Genuine Wrought Iron.

R/M operates 4 strategically located plants working night and day, turning out packing that can take it. Longer service for over-worked steam lines, oil lines, fuel lines and air lines is R/M's specialty . . . and has been for years.

Consult your local R/M distributor on all packing jobs. He can furnish you with the right packing for every purpose. Ask him for a copy of the R/M catalog, too, or write us direct.



ARMY E NAVY

Awarded to R/M
North Charleston Plant

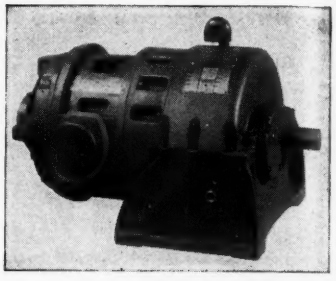
INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.
BRIDGEPORT, CONN. NORTH CHARLESTON, S. C. PASSAIC, N. J.
Makers of Packings for Every Industrial Use

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE TO POWER PLANT ENGINEERING

Gearmotors

A NEW LINE of horizontal parallel shaft type gearmotors which meet speed reduction requirements for a wide variety of industrial applications over a range of 1 to 75 hp is announced by Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. These new units conform to A.G.M.A. standard output speeds and application practices.



These new gearmotors are compact and foundation stability has been improved through heavy exterior ribbing of the housing at each mounting hole. The use of adaptor castings between motor and mechanical parts allows the use of all standard Westinghouse N.E.M.A. frame motors with each type of unit, thereby allowing types of motor construction to be changed readily to suit varying service requirements in the field. The motor adaptor assembly design is common between unit types which permits the assembly to be shifted between unit types to meet changes in speed requirements. Many working parts, including gear sets, are common to all three unit types of given rating so that replacement parts are held to a minimum. Gears and pinions in the new units are of .40-.50 carbon steel and are given special heat-treatment before hobbing. Gears and bearings are lubricated by a positive splash system and the new case design allows oil to circulate freely at all times.

Invisible Photoelectric Protection System

A NEW PHOTOELECTRIC protection system which projects a fence of invisible light over distances as great as 1500 ft and gives instant local or central-station alarm if an intruder enters the protected area is now available from Photoswitch Incorporated, 77 Broadway, Cambridge, Mass. Designed to meet government requirements, the new equipment has an operating range longer than that of any other photoelectric system, it is stated, and is suited to the protection of harbors, yards, docks, industrial properties, airports, and similar large areas.

In operation, Light Source Type L60M is alined with Receiver Type A30M to which it focuses a modulated beam of infra-red light. Because Type A30M responds only to the frequency of light emitted from the light source it is not affected by other artificial light or by

Why We Are Advertising Now

Surely, not to get more immediate business. Our entire facilities are devoted solely to the war effort. Our combined engineering experience and production ability is centered on one objective:... winning the war.

For decades the names Hendy, Pomona and Crocker-Wheeler have been familiar to you. That these names may be kept fresh in your mind until the war is won and we can again solicit your business, is the reason we're advertising now... telling you about our facilities, the products we're making, the personnel of the Hendy organization and such other things as we can publish without jeopardizing the war effort.

THE IRON MEN OF HENDY
...are now producing marine steam engines, steam turbines, and reduction gears; electric motors, fractional to 10,000 h.p.; generators, 3 to 7,500 KW; hydraulic pumps with capacities from 50 to 6 million gallons per hour... all exclusively for the war effort.

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ESTABLISHED 1856

SUNNYVALE • CALIFORNIA

Divisions: POMONA PUMP COMPANY
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Manufacturing Plants: SUNNYVALE, LONG BEACH, POMONA and TORRANCE in CALIFORNIA • AMPERE, N. J. • ST. LOUIS, MO

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Unequaled Flow Characteristics Low Pressure Loss and Maintenance

36-inch valve with welding end, carbon-moly body and four to six per cent chrome-moly vane. Equipped with alloy shafts and bushings, finned lubricated stuffing box and hydraulic cylinder with positioner. The auxiliary heavy duty hand wheel control is equipped with self-locking worm and gear and declutching unit.

Standard 125 lb hand lever operated valve. Can be equipped with hand wheel, chain lever or chain wheel. An extension shaft is provided for inaccessible locations.

R-S QUALITY PRODUCTS SINCE 1908

15 to 900 psi
for air, gas, steam, liquids and semi-solids

A glance at the design of an R-S Butterfly Valve indicates that there is practically no restriction to the flow. The carefully-machined body bore and streamlined vane offer minimum resistance. In fact, the flow conditions are similar to those produced in a venturi tube with high pressure recovery on the downstream side.

It is apparent that the pressure loss in a wide open R-S Butterfly Valve is considerably less than in most conventional types of wedge gates. Add to this the fact that there are no pockets to collect sediment. When the vane approaches a closed position, the valve tends to clean itself.

Shut-off is accomplished by the beveled vane which wedges tight against the valve body. Four to six revolutions of a hand wheel completely open or close the valve vane. Accurate control and shut-off by hand or automatic equipment is a simple matter.

Where hard wear and severe stresses are encountered, the use of R-S "A" metal will produce outstanding results and increased service. Specify R-S Butterfly Valves for reduced maintenance.

Catalog No. 16-B contains detailed specifications. Write for your copy.

VALVE DIVISION
R-S PRODUCTS CORPORATION
4535 Germantown Avenue • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

daylight. This permits extreme sensitivity, enabling the equipment to function over a greater range than it has been previously possible to cover with photoelectric controls. If invisible infra-red light is not required, the operating range of the system exceeds 2000 ft.

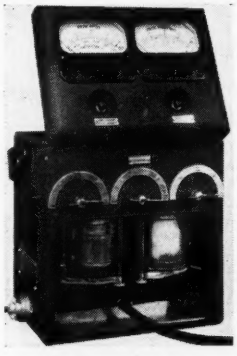
Within Light Source Type L60M, a fan driven by a gearless, brushless motor, serves as a light chopper to produce rapidly fluctuating light of the desired frequency, and also cools the heavy-duty lamp, assuring long life. Once the invisible beam of light projected to Receiver Type A30M is momentarily broken, the alarm circuit latches in operation. An additional safety feature is that either power or tube failure will cause the alarm circuit to operate as though the light beam had been broken.

Receiver Type A30M and Light Source Type L60M are of rugged construction and are furnished in weatherproof housing. An auxiliary latching relay with reset button is supplied with these units.

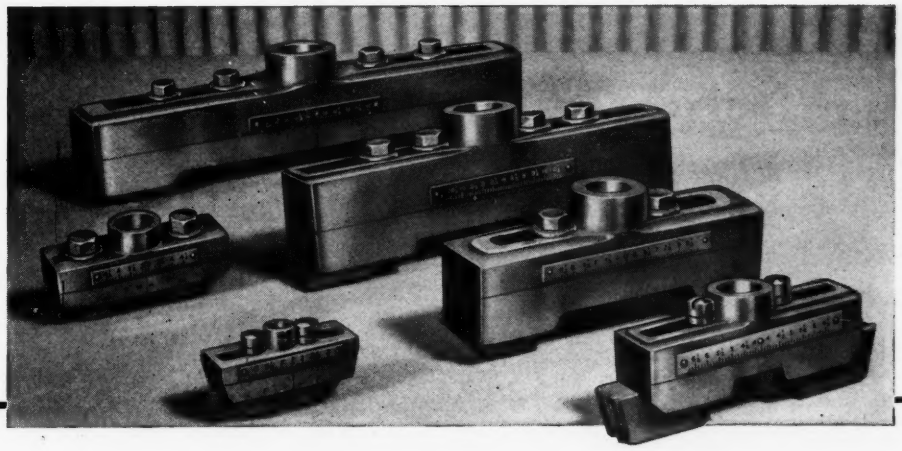
The Heat Prover

To aid in utilizing fuel at peak efficiency in power plants and industrial plants, Cities Service Oil Co. has adopted a policy of providing a complete combustion control service without charge to its customers. To provide a method of analyzing existing combustion conditions so that proper steps can be taken to improve them, the company has developed the Heat Prover, shown herewith, for measuring both the unburned fuel and excess of oxygen in flue gas from steam power plants, open hearth furnaces, heat treating apparatus and other industrial heating equipment and in the exhaust of internal combustion engines.

The Heat Prover operates on the heat conductivity principle. It is portable, weighs about 25 lb, includes a sample tip, 50 ft of hose, a thermocouple for high temperature measurement and operates electrically on 25 or 50-cycles, 110 or 120-v, a-c.

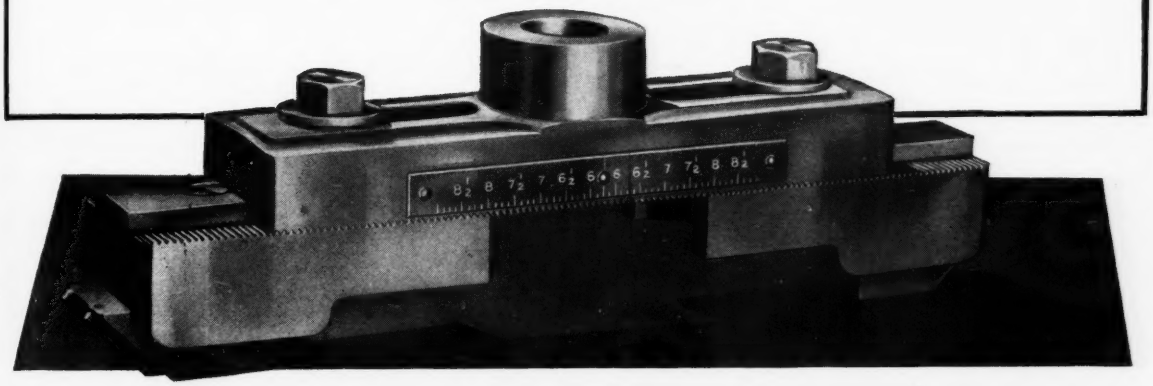


The instrument consists of two parts, one designed to measure unburned fuel, the other to measure excess oxygen in the spent gases. To measure the unburned fuel, a sample of the gas is drawn into the apparatus, mixed with excess air and passed over a catalytically-active, heated platinum wire forming one arm of the Wheatstone bridge circuit. Any unburned fuel will burn on the surface of the wire, throwing the circuit out of balance and causing the indicator to register directly in terms of per cent combustible. To measure the oxygen content, a sample of the gas is mixed with hydrogen and passed over a duplicate of the hot wire circuit described



NEW DEXTER CUTTERS

AVAILABLE FOR ANY DEXTER VALVE RESEATING EQUIPMENT NOW IN USE



...will completely cover any seat variations
...cut any seat material

The Leavitt Machine Company announces *new-type* cutters and cutter inserts, all of which are available for any Dexter Valve Reseating Equipment now in use . . . all of which have passed tests under every type of condition.

Summed up, here are three important things to remember about this new Dexter Equipment:

(1) The adjustable cutters will adequately cover completely *all* seat variations.

(2) The interchangeable cutter inserts will handle *any* seat angles.

(3) The Tantalum Carbide Tipped inserts will cut *any* seat material.

The cutters are furnished in combinations . . . one combination for all flat seats; other combinations for 45°, 55°, and 75° angle seats. Cutters for reseating seats in 2″ valves and larger are of the adjustable type provided with interchangeable inserts for the different size valves and angles encountered. Cutters for seats in smaller than 2″ valves are covered by our multiple type suitable for reseating the seats of more than one type or size of valve.

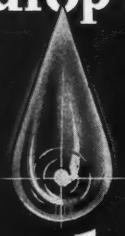
For further information about Dexter Valve Reseating Equipment or the new Dexter Cutters write:

LEAVITT MACHINE COMPANY, Orange, Mass.

DEXTER

Valve Reseating Equipment

Just a drop of water-



harmless···

or is it?

Although specially treated for use in your water consuming equipment, it may still contain a sufficient amount of water hardness to cause boiler scale, priming, foaming, pitting or corrosion or caustic embrittlement.

There's no question about feed water conditioned by nature's own method discovered in the new TECHNICAL Water Conditioning System . . . a perfect balance of water's mineral content with correct, natural *organic substances.*

Technical

WATER CONDITIONING SYSTEM

TECHNICAL is a proven, natural system of individual formulas to fit each and every water type. It provides a special balance of water properties that definitely overcome scale, foaming, pitting, corrosion, priming, caustic embrittlement characteristic of boilers and condenser covering systems.

For your own satisfaction, investigate the new TECHNICAL System . . . Nature's own conditioning method developed under actual industrial operating conditions. Without obligation the coupon below will bring you the facts.

WATER TREATMENT COMPANY OF AMERICA

1159 Hodgkiss Street · Pittsburgh, Pa.

☐ Please send the new Technical System bulletin.

☐ Haye a Water Treatment Company engineer call.

Name_____ Title_____

Company_____

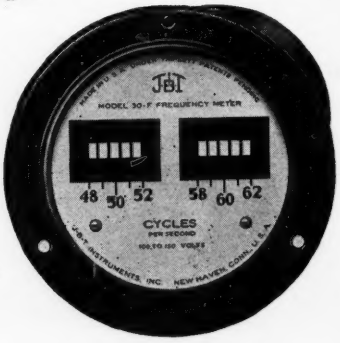
Address_____

above. Any oxygen present will burn with the hydrogen, unbalance the bridge circuit and cause the meter to register directly in per cent oxygen. This second indicator may also indicate the stack or exhaust temperature in degrees Fahrenheit. All operations are entirely automatic. The meter readings of each Heat Prover are verified by trained operators every 30 days with bottled gases of known composition.

Vibrating Reed Frequency Meters

A NEW J-B-T vibrating reed frequency meter for use on engine generator sets, in laboratories, telephone and radio service, for panel and control boards in central stations and industrial plants, has recently been developed by J-B-T Instruments, Inc., New Haven, Conn.

In this device a series of spring steel reeds, each one adjusted to respond by resonance to only one frequency, are actuated by a driving coil operated by alternating current or interrupted direct current. The one reed in tune with the frequency in the coils will respond by vibrating rapidly and the frequency is read opposite that reed on the graduated face of the instrument. A series resistor adapts the instrument to specified operating voltages.



The instrument is stated to be accurate within plus or minus 0.3 per cent on full cycle increments and plus or minus 0.2 per cent on half cycle increments at normal temperatures. Combinations of reeds as low as 20 cycles or up to 425 cycles are standard, other ranges for special services. Full or half cycle increments are standard construction. Power consumption is stated to be less than 2 watts average at 115 v, depending on the model. The voltage range is from 8 v up. Normal range is plus or minus 20 per cent of specified voltage on frequencies outside the reed range.

Boiler Feed Systems

AN EXPANSION of the line of Johnson high temperature boiler feed systems which proved so effective in helping wartime industry reduce pumping and maintenance costs and save fuel, has been announced by the Johnson Corp., of Three Rivers, Mich. All sizes of the Johnson System are now available with either a standard coupled type of pump, or the close coupled type originally furnished. In addition, a new larger size of the pumping unit has been developed, making the system available now for use with boilers from 30 hp. to 500 hp., operating at pressures up to 150 lb.

Prevent Valve Failure *before it starts!*

COMPARE

ABRASIVE WEAR

ruins a Yoke Sleeve—forces a shutdown when lubrication is neglected

Because regular lubrication was neglected, this yoke sleeve from an OS&Y Gate Valve wore out rapidly and failed in service. Important plant operations were stalled when the line was shut down to make the necessary replacement.

As the illustrations indicate, the original sturdy flange on the base of the yoke sleeve (or bushing) was reduced to a wafer-thin "washer" by abrasive wear, and then it sheared off. Since the (yoke sleeve) flange must withstand the entire thrust when the valve is tightly closed, and also when the valve is back seated in the fully open position, it is extremely important that its original strength be maintained by proper lubrication and care.

"Hit or miss" lubrication schedules also take their toll of outside spindles, as illustrated. Threads left dry and unprotected are worn by grinding grit on the thread bearing surfaces, threatening sudden failure and injury to operatives, as well as damage to property.

Such production-stalling, metal-wasting valve failure *can* be prevented. Inspect valves frequently, systematically. Repair or replace worn parts in time to prevent valves from destroying themselves. See that new valves are carefully selected, installed by experts. And train new men in care and maintenance.

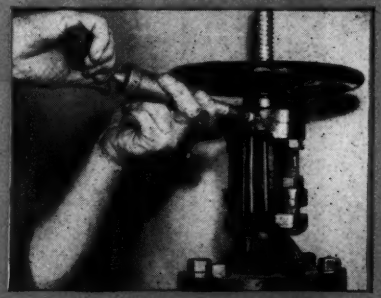
Jenkins Engineers will assist any management in preparing an effective program of valve conservation.

A few cents worth of lubrication — regularly applied — would have saved this spindle

Lubricate Valves on Schedule

—at least Once a Month—to prevent such failures

Jenkins Iron and Steel OS&Y Gate Valves have a drilled hole in the yoke cap to supply oil to the moving parts. On the larger size valves, a grease gun fitting is provided in place of the oil hole.



Valves should be lubricated once a month, more often when operated frequently. Outside screw threads should also be cleaned and lubricated, and shielded when dust conditions are severe.

Jenkins Bros., 80 White Street, New York, 13, N. Y.; Bridgeport; Atlanta; Boston; Philadelphia; Chicago. Jenkins Bros., Ltd., Montreal; London.

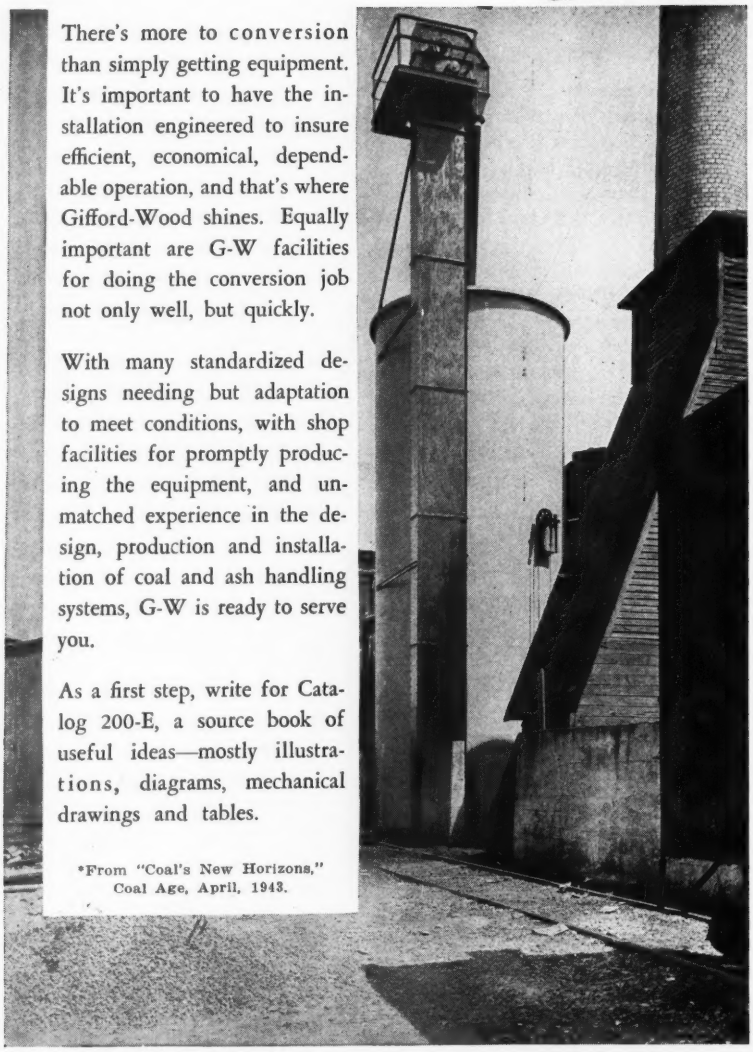
JENKINS VALVES

SINCE 1864

For every industrial, engineering, marine and power plant service . . . in Bronze, Iron, Cast Steel and Corrosion-Resisting Alloys . . . 125 to 600 lbs. pressure.

Quoting SECRETARY ICKES!:

"A high percentage of industrial plants now converted to coal will not re-convert to oil"*



There's more to conversion than simply getting equipment. It's important to have the installation engineered to insure efficient, economical, dependable operation, and that's where Gifford-Wood shines. Equally important are G-W facilities for doing the conversion job not only well, but quickly.

With many standardized designs needing but adaptation to meet conditions, with shop facilities for promptly producing the equipment, and unmatched experience in the design, production and installation of coal and ash handling systems, G-W is ready to serve you.

As a first step, write for Catalog 200-E, a source book of useful ideas—mostly illustrations, diagrams, mechanical drawings and tables.

*From "Coal's New Horizons," Coal Age, April, 1943.

GIFFORD-WOOD CO.

FOUNDED 1814

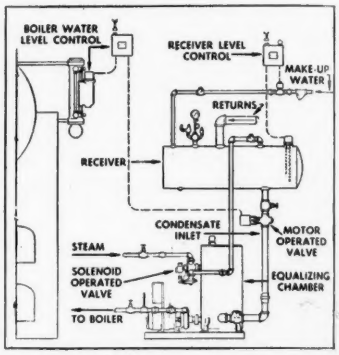
420 Lexington Avenue, New York — **HUDSON, N. Y.** — 565 W. Washington Street, Chicago

Ash Spouts • Barge Unloading • Bins • Boiler House Equipment • Buckets • Bunkers • Carriers • Chutes
Conveyors • Crushers • Elevators • Feeders • Gates • Ground Storage Systems • Hoists • Hoppers
Infra-Red Drying Systems • Screens • Silo Storage Plants • Tanks • Weigh Larries

4236

The new pumping unit, like the original close coupled type, employs the Johnson "Pressure Equalizing" principle of operation. This system admits boiler pressure to an equalizing chamber behind the pump during operating cycles, which leaves only the task of raising the returned condensate a few feet to the boiler water level.

Savings in fuel are obtained by venting the equalizing chamber of the pump unit to the condensate receiver. This makes it possible to maintain a slight controlled pressure on the returns. Condensate, consequently, can be returned to the boiler at far higher temperatures than is possible under atmospheric pressure or vacuum conditions.



The diagram shows the operation of the system. When boiler needs water, boiler control opens valve to allow condensate to flow from receiver to pump equalizing chamber. Boiler pressure is admitted to equalizing chamber and pump started. When boiler is satisfied and pump stopped, pressure is vented to receiver. This provides a slight controlled pressure on returns, permits condensate to be pumped at higher temperatures. Automatic vent on receiver disposes of air and noncondensable gases. Receiver level control adds make-up water when necessary.

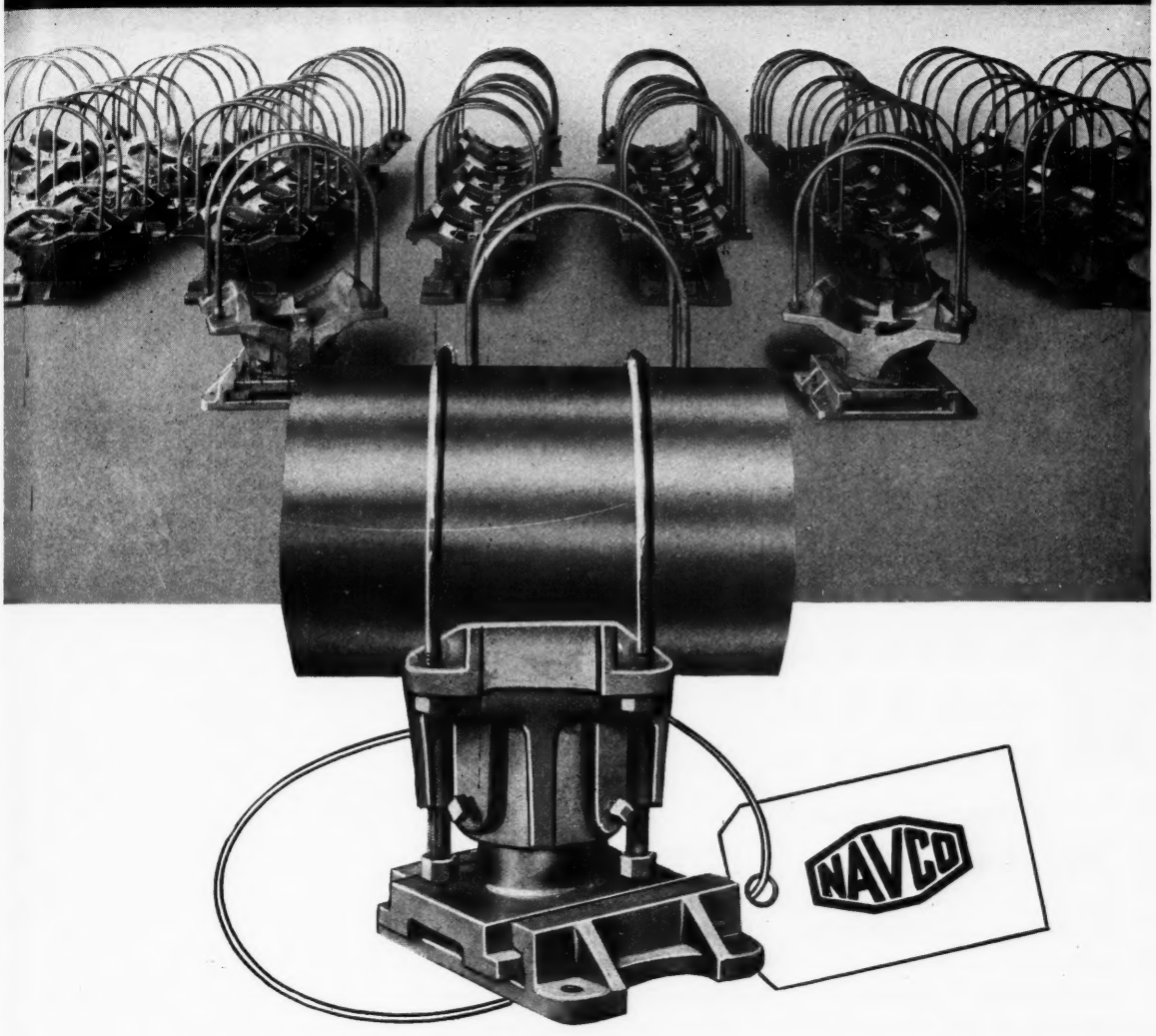
Everything necessary for dependable automatic boiler feeding is provided in the Johnson system. Motionless metal electrodes are placed at the boiler water line to signal the pump whenever the boiler needs water. Automatic vent on condensate receiver disposes of air and noncondensable gases picked up in the system. Auxiliary water level control in receiver adds make-up water to system whenever necessary.

Indoor Dry-Type Transformers

A NEW SERIES of dry-type natural-draft transformers for indoor use on 600 v and below is announced by the General Electric Co. The size and weight of the new transformers have been materially reduced, permitting lighter foundations and requiring less floor space. Louvered side plates slant inward at the bottom and top of the case, permitting a directed flow of air through the case vertically, entering at the bottom, passing through the coil ducts, and out through the louvers with little change in direction.

This new transformer has a two-legged core with a high and a low voltage coil on each leg. The core is clamped at its top and bottom, with the bottom clamps serving as mounting feet. This provides a base, being drilled so that the transformer may be bolted to

NAVCO "UNIVERSAL" PIPE SUPPORTS



Navco Universal Support will take care of eight inches of expansion and can be made special to accommodate any amount of travel.

Vertical adjustment up to 2½ inches can be made.

Support may be turned to any angle of 360°.

Holds pipe down as well as up. Prevents pipe from getting out of alignment, which is usual in the Roller Type of support.

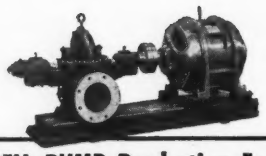
It permits control of expansion movement of pipe and insures the desired free action of Slip Expansion Joints so essential in tunnel and duct work.

Carrier is fixed to a predetermined point on the pipe, thereby eliminating possibility of destroying insulation. There is a recess in the saddle for insulation and the entire support can be insulated on the outside.

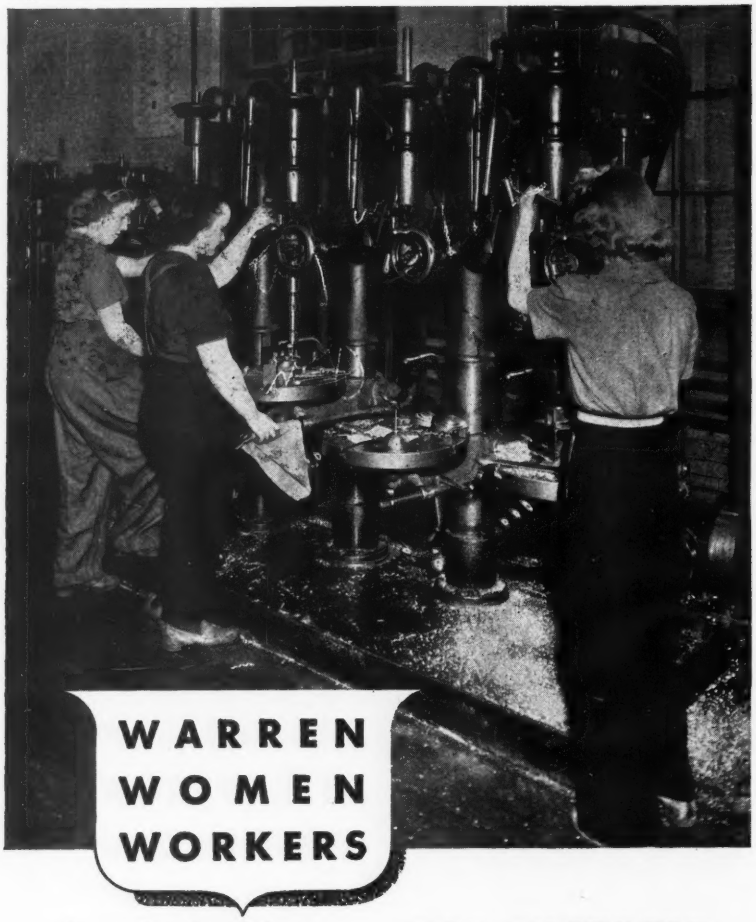
Navco Universal Pipe Supports are made of cast iron but can also be furnished in steel at increased prices. For installations exposed to the weather, bases can be furnished with brass liners or provided with forced lubrication.

NATIONAL VALVE MANUFACTURING COMPANY • PITTSBURGH, PA.

ATLANTA BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA



Fighters on the WARREN PUMP Production Front. No. 5 of a Series



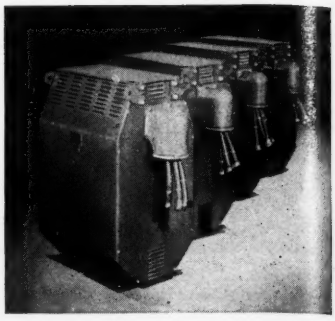
***do their bit . . .* FOR VICTORY!**

No glamor . . . no fanfare to the job of machining small pump parts . . . or to many other types of work now being successfully performed by women in the plant of the Warren Steam Pump Company. Carefully trained and supervised by veteran Warren workmen, these women apply themselves diligently to the tasks at hand . . . not unmindful of the reputation that Warren Pumps have always enjoyed for efficiency, reliability and economy. Their contribution to our all-out war effort is real . . . substantial . . . patriotic.

WARREN SALUTES ITS WOMEN WORKERS!

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

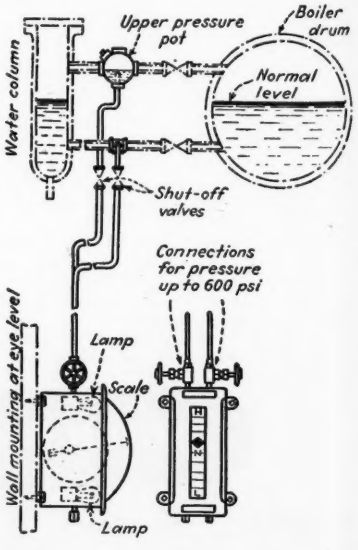


the mounting surface if desired. The top clamps are used for lifting the transformer and also serve as the upper bracket, if the transformer is wall mounted. Because of the unusual case design, the unit can be mounted against a wall or close to other units with little or no effect on temperature rise. The coils are exposed for maximum cooling with a large portion of their copper outside the core. The high and low voltage coils are concentric with air ducts between them which provide extra insulation and cooling. Use of two small coils instead of one large coil permits them to be designed with more turns of smaller wire for the same copper loss, resulting in lower exciting current and lower inrush currents when the primary of the transformer is energized.

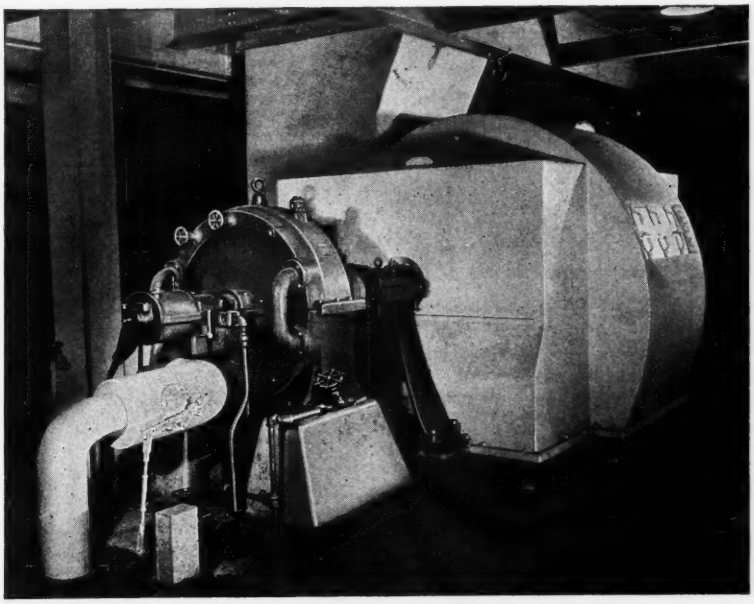
The case is made of light gage steel with removable top and side plates to facilitate cleaning and inspecting the coils.

Remote Water-Level Indicator

NEW INSTRUMENT, wall or panel mounted at eye level, to show level of water level in boiler drum has recently been announced by Yarnall-Waring Co., Philadelphia, Penna. Instrument is operated by difference in pressure in connecting tubes (see hookup) which is the difference in head between a fixed water level in an upper pressure pot and the varying water level in the boiler drum.



TERRY



BUCKETS AND ROTOR IN THE TERRY WHEEL TURBINE
. . ALL IN ONE PIECE

In the Terry Turbine the wheel is made from a single forging of special composition steel. The buckets are milled directly in the wheel. There are no parts to become loose or work out. Such construction makes for long life and low maintenance.

This and many other features of Terry Wheel Turbine design are described in our Bulletin S-116. A request on your business letterhead will bring a copy.

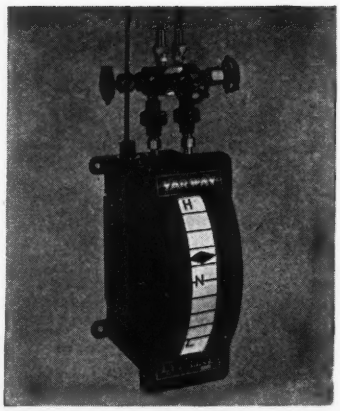
ABOVE: 250 H.P. Terry Wheel Turbine driving Induced Draft Fan. Unit is one of ten Terrys installed in a mid-western plant.

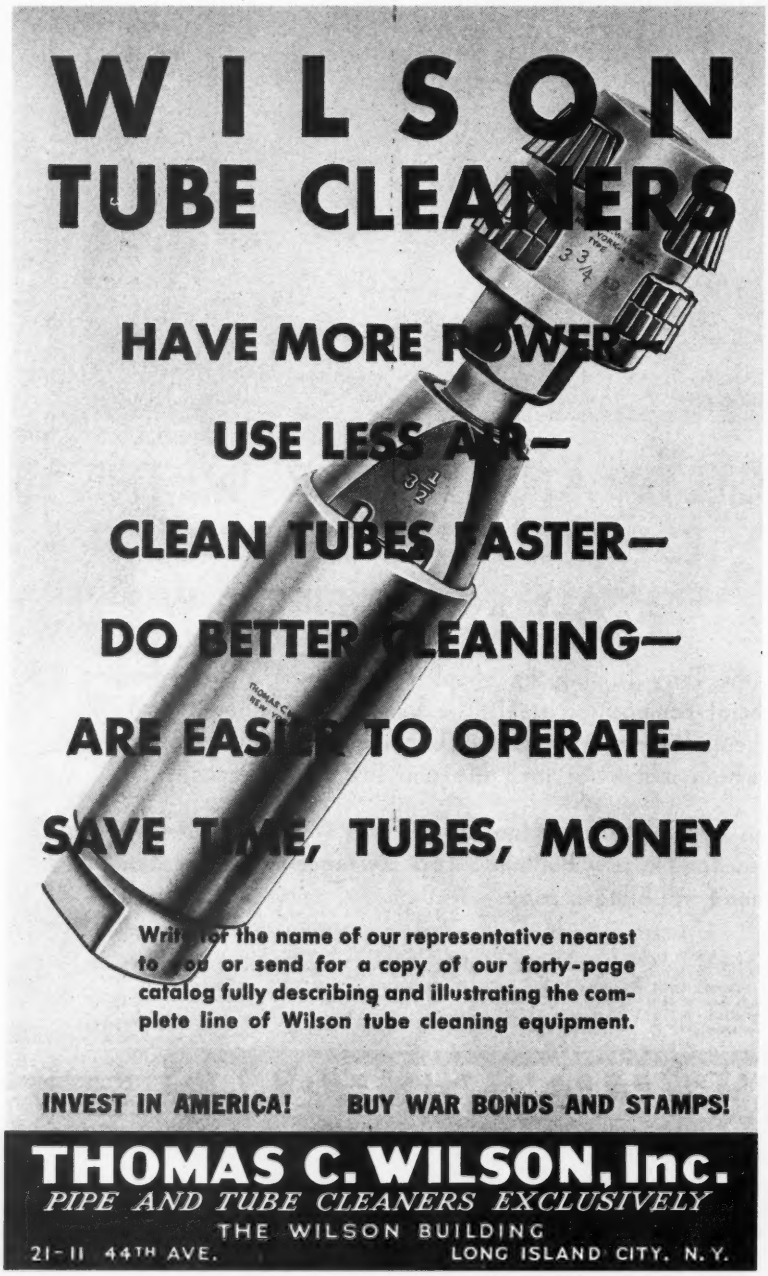
T-1153

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Pressure differential acts on a Neoprene diaphragm the force of which moves a powerful permanent magnet along a bronze alloy tubular well containing a spiral armature of magnetic material. Thus rotation of the armature, and corresponding greatly-magnified motion of the pointer, is in direct proportion to the diaphragm motion. The magnetic principle permits complete separation of pressure parts from nonpressure parts without stuffing boxes.

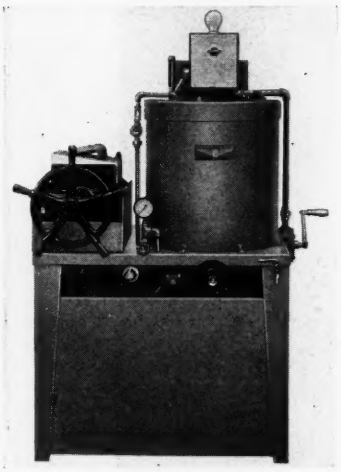
The balanced black pointer registers changes in boiler water level on an illuminated scale that shows green for normal operating range and red at high and low levels. An adjusting screw changes the scale range and another adjusts the instrument zero. Two models serve all boiler pressures up to 1500 psi.




WILSON
TUBE CLEANERS
HAVE MORE POWER—
USE LESS AIR—
CLEAN TUBES FASTER—
DO BETTER CLEANING—
ARE EASIER TO OPERATE—
SAVE TIME, TUBES, MONEY
Write for the name of our representative nearest to you or send for a copy of our forty-page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.
INVEST IN AMERICA! BUY WAR BONDS AND STAMPS!
THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
THE WILSON BUILDING
21-11 44TH AVE. LONG ISLAND CITY, N. Y.

Small Capacity Oil Reclaimer

A NEW SMALL CAPACITY lubricating oil reclaimer, Model A-8, designed for small plants and organizations having their own fleet of trucks and motor cars, is announced by the Youngstown Miller Co., Sandusky, Ohio. In addition to reclaiming lubricating oils of the motor fleet, this reclaimer can usually handle a limited quantity of waste lubricating oils drained from equipment used in the plant or manufacturing processes.



It is claimed that this new reclaimer will handle 2500 gal of waste lubricating oil per year when operated only once a day, having a capacity for purifying 8 gal of dirty oil in 70 to 90 min. The machine has a two-stage filter press, is semi-automatic, operating under thermostatic control, and utilizes common refinery earths available on the open market. It is stated that based on average prices for new oil, the reclamation of waste oil will generally enable the machine to pay for itself in six to 12 mo.

Outdoor Photoelectric Relay

A NEW GENERAL-PURPOSE photoelectric relay for outdoor use, designated as Type CR7505-K108, has been announced by the Electronic Control Section of General

Electric Company. It is applicable to installations requiring rapid and accurate counting, controlling, sorting, or limiting operations. Its contacts control 2 amp at 115 v, 25 to 60 cycles, alternating current, or 0.5 amp at 115 v, d.c.

Exact INCLUDED ANGLE

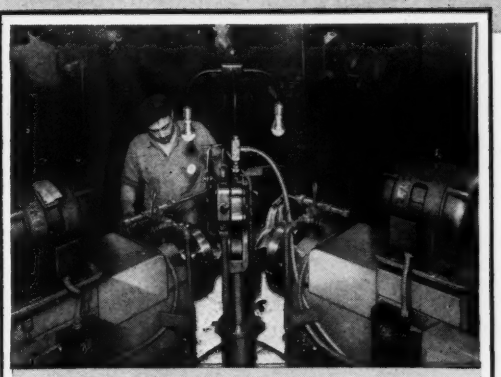
ANOTHER REASON WHY MIDWEST WELDING ELBOWS Are So Often Preferred

There are several important reasons why, among qualified pipe welders, Midwest Welding Elbows have earned a reputation for exceptional dimensional accuracy and uniformity. One reason is because the included angle of 90° or 45° between the machine-beveled ends is always exact . . . both ends are simultaneously machined as shown at the right. The elbow's final sizing in compression makes it possible for the fixture to clamp it in accurate position—so the center-to-end dimension is always the same.

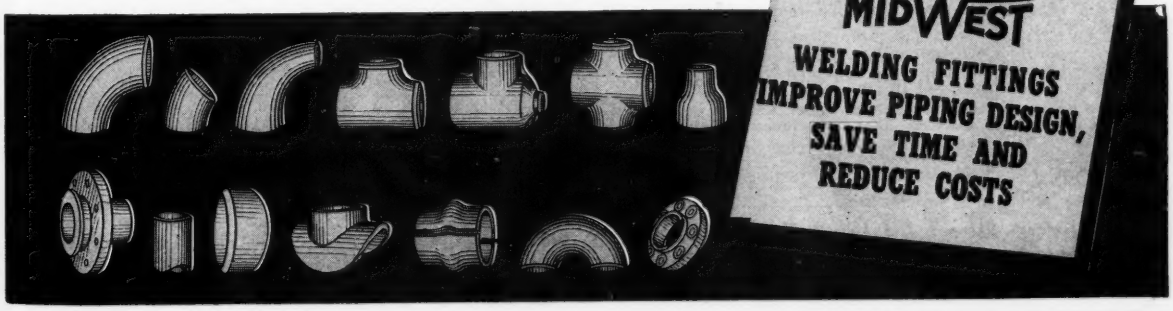
For data on all the advantages of Midwest Elbows . . . and the other Midwest Welding Fittings . . . ask for Bulletin WF-41.

MIDWEST PIPING & SUPPLY CO., Inc.

Main Office: 1450 South Second St., St. Louis, Mo.
Plants: St. Louis, Passaic (N.J.) and Los Angeles
Sales Offices: Chicago—645 Marquette Bldg. • Houston—229 Shell Bldg.
Los Angeles—520 Anderson Street • Tulsa—533 Mayo Bldg.
New York—(Eastern Division) 30 Church Street



Shown here is one of the machines especially built by Midwest for simultaneously machine-beveling both ends of Midwest Welding Elbows and holding the included angle within extremely close limits. Special fixtures and special tools were also developed for this work. Similar machines with three heads are used for finishing Midwest Tees.



MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN, SAVE TIME AND REDUCE COSTS

It Pays to Ask for CHESTERTON

Parachute Packing

★ Fully automatic . . . tailor-made to suit predetermined expansion . . . No backing-off of gland; no bothersome after-adjustments . . . Fully molded bottom ring cannot roll or twist in box . . . Insures substantial savings in plant maintenance.

Chesterton Packings are sold in all principal cities by *Factory-Trained* Distributors. Write today for Catalog 20-E giving full details.

A. W. CHESTERTON CO.

64 INDIA STREET, BOSTON, MASS.

FACTORIES: MELROSE, MASS., CHICAGO, ILL.

Get Old Valves Back On Their Feet Again

—at less than half of the new valve cost

FOR VICTORY'S SAKE reclaim all your Iron, Steel or Brass valves. Every old valve put back in service means that another new one is available for vital war industry—to keep production lines flowing.

Send us those leaky old gate and globe valves you had planned to discard. Our experienced "Valve Doctors" will repair worn seats, discs and other parts. Our charges never exceed 50% of the original valve price; and they usually run around 35%. We pay shipping costs both ways on valves that can't be fixed.

For Victory, Salvage Old Valves — Send Them To

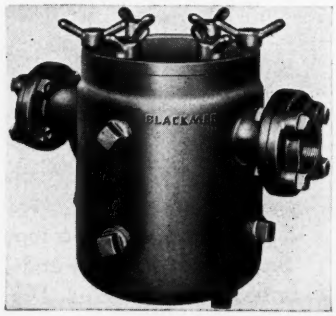
THE COMBUSTION EQUIPMENT & INSULATION CO.

Factory at Greenlawn and Erie R. R. Tracks, Lima, Ohio

This new relay contains a Type GL-930 phototube and a Type GE-117P7GT pliotron tube. It can be mounted in any position and can be adjusted under actual operating conditions without removing the cover. The chassis can be removed easily from the case for inspection or servicing, or, if desired, for mounting with other apparatus in a combination enclosure. The case is weatherproof and equipped with a sun shield and a large, directional lens system to minimize the effect of slanting sun rays. This lens system also increases the relay's sensitivity.

Steam-Jacketed Strainer

BLACKMER PUMP Co., Grand Rapids, Mich., is now supplying a new strainer for handling highly viscous liquids or liquids that are solid at room temperatures. These strainers are steam-jacketed and used to maintain the liquid in the strainer at the same temperature as in the piping. They were developed primarily to speed the handling of difficult liquids in war production plants.



Standard capacities are 20, 50, 100 and 200 gpm. Pipe sizes 1, 2 and 3 in. Maximum operating pressure is 50 psi at temperature of 600 F. The jacket is suitable for 125 psi.

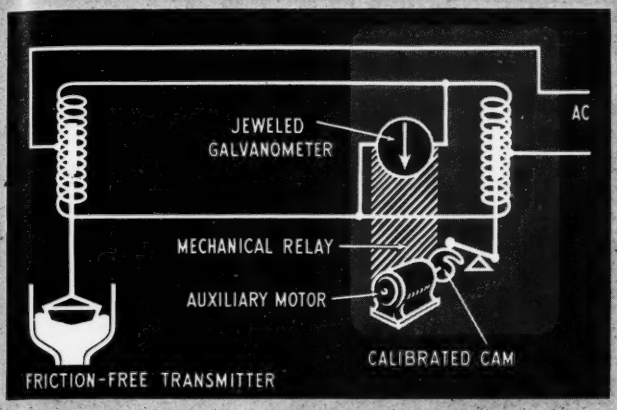
The bottom and sides of the unit are completely enclosed in a steam jacket. Two inlet and two outlet ports are provided for steam line connection.

OBITUARIES

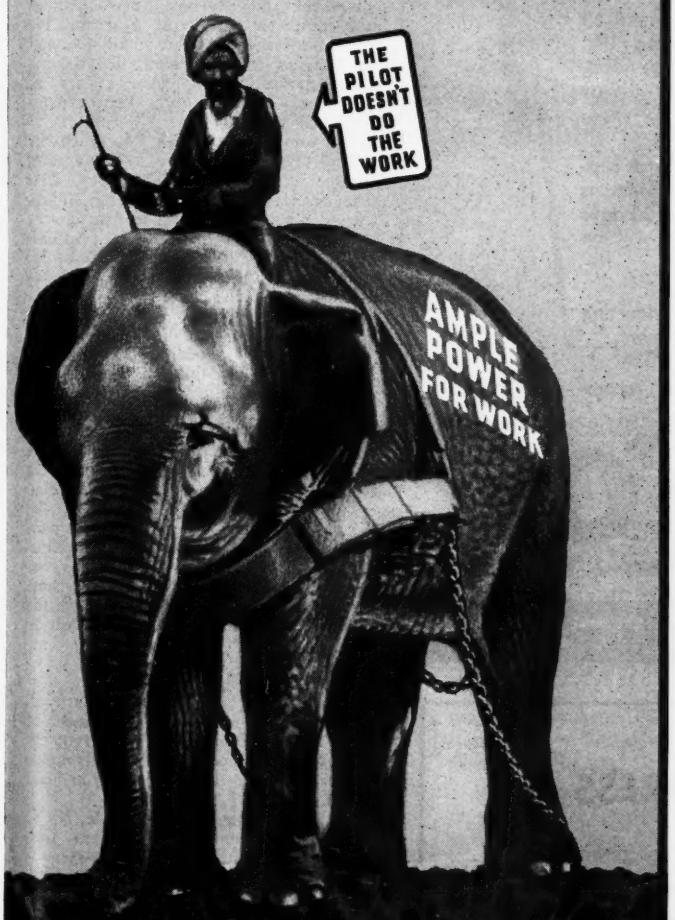
Zechariah Chafee

ZECHARIAH CHAFEE, president of Builders Iron Foundry, Providence, R. I., died at his home on the outskirts of Taunton, Mass., on July 8, 1943. He was 84 yr old.

Mr. Chafee was born in Providence in 1859 and attended the University Grammar School and Brown University. After he was graduated from college he entered the Builders Iron Foundry, which was conducted by his father, and upon the latter's death in 1889, became president, holding that office until his death. Mr. Chafee was also connected with the Brown & Sharpe Mfg. Co. from 1887 to 1897 and was a member of the Board of Directors of various banks and trust companies. In 1915 he became the first of the Alumni Trustees of Brown University and in 1927 was elected a permanent trustee and a member of the Board of Fellows.



In the Cochrane Flow Meter, the Null or Zero Balance principle is employed, balancing the unknown quantity by adjusting a known quantity of the same kind. A highly sensitive detector is used to determine the point of balance. A friction-free transmitter serves as a pilot for an external motor drive. The motor restores the bridge to balance and operates recording pen, indicating pointer, and integrator. The measuring circuit is relieved of all work.



Another Low Maintenance Feature ---the Large Reservoir Pen

The giant glass pen in the Cochrane Flow Meter recorder is another of the many features designed to minimize the amount of attention required in the operation of the meter. The reservoir holds a month's supply of ink. The point is tipped with platinum-iridium, for almost indefinite wear.

For other Cochrane features, see Cochrane Publication 3010. A copy will be sent upon request.

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia 32, Pa.

COCHRANE FLOW METERS

The

ENEMY

of

- SCALE
- SLIME
- RUST
- DIRT
- ALGAE

• **SOL-VET "08"** is a fast, efficient cleaner of all equipment using water for cooling. By dissolving impurities *completely*, they are carried out *in solution*, thus preventing clogging. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours.

GUARANTEED EFFECTIVE
If you find SOL-VET "08" is not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be *refunded in full.*

GUARANTEED HARMLESS
when used as directed, to all water conducting materials used in water cooled equipment.

WRITE TODAY
for complete data and analysis and recommendations for your specific problem.

SOL-VET "08"

Water Treatment Formula

MANUFACTURED and GUARANTEED by

ANDERSON-STOLZ CORPORATION
1733 WALNUT STREET • • • KANSAS CITY, MISSOURI

CHANGE OF ADDRESS

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

POWER PLANT ENGINEERING

George E. Andrews

GEORGE EDWARD ANDREWS, director of research for POWER PLANT ENGINEERING, died very suddenly on July 9, while on the way from his office to his home in Evanston, Ill. He was 69 yr old.

Mr. Andrews was born in Newfields, N. H. He was graduated from Phillips Exeter Academy and from Wesleyan University, Middletown, Connecticut.

He was connected with the Library Bureau for a time in the sale of office equipment and developed new methods and equipment for filing systems. He then joined the Hill Publishing Co. and the McGraw-Hill Publishing Co., serving this organization for many years as advertising representative, district manager, and executive.

He joined the staff of POWER PLANT ENGINEERING in January 1937 as sales manager in the Cleveland territory. Last year he was appointed director of research in the home office in Chicago.

Mr. Andrews is survived by his widow, and by a daughter, Mrs. E. M. Holmes, and a son, Edward M. Andrews of Saginaw, Mich.

Leonard G. Calder

LEONARD G. CALDER, 73, President of The Bird-Archer Company, Limited, and Director of The Bird-Archer Co., of New York City, died suddenly in Montreal on June 14, 1943. Mr. Calder was born in Columbia, Tenn., and received his early education in the United States. He entered the service of the Canadian Pacific Railway in 1891. In 1929 he became vice-president and general manager of The Bird-Archer Company, Limited, and a director of The Bird-Archer Co. of New York. In 1932 he became president and managing director of the Montreal Company, holding this position until his death.

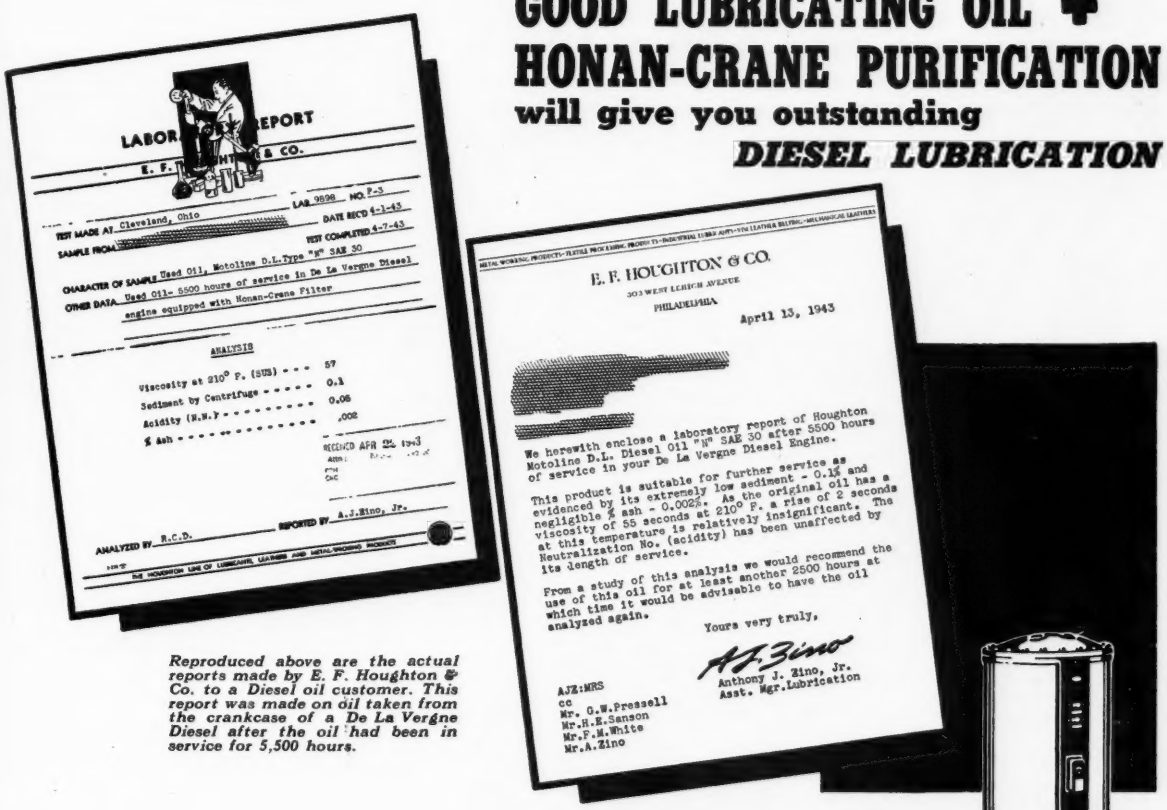
Dr. William J. Foster

DR. WILLIAM J. FOSTER, electrical pioneer and former assistant engineer of General Electric's alternating-current engineering department, died at his home in Schenectady, July 2, after a brief illness. He was 82 years old.

Dr. Foster was born in Argyle, N. Y., was graduated in 1884 at Williams College, received the degree of master of science from Cornell University in 1891, and became associated with the General Electric Co. at its Lynn Works the same year.

From 1893 until his retirement in 1929, Dr. Foster took an active part in the design of every important alternating-current machine built by the General Electric Co. For many years he was responsible for the electrical design of all synchronous machines, and in this

PROOF— actual and authentic proof that GOOD LUBRICATING OIL + HONAN-CRANE PURIFICATION will give you outstanding *DIESEL LUBRICATION*



LABOR[illegible]EPORT

E. F. [illegible]NT[illegible] & CO.

TEST MADE AT Cleveland, Ohio — LAB. 9896 NO. P-5

SAMPLE FROM [illegible] — DATE RECD 4-1-43

TEST COMPLETED 4-7-43

CHARACTER OF SAMPLE Used Oil, Motoline D.L.Type "N" SAE 30

OTHER DATA Used Oil- 5500 hours of service in De La Vergne Diesel engine equipped with Honan-Crane Filter

ANALYSIS

Viscosity at 210° F. (SUS)	57
Sediment by Centrifuge	0.1
Acidity (N.N.)	0.08
% Ash	.002

RECEIVED APR 22 1943

ANALYZED BY R.C.D. REPORTED BY A.J.Zino, Jr.

THE HOUGHTON LINE OF LUBRICANTS, LEATHERS AND METAL-WORKING PRODUCTS

E. F. HOUGHTON & CO.

303 WEST LEHIGH AVENUE

PHILADELPHIA

April 13, 1943

[illegible]

We herewith enclose a laboratory report of Houghton Motoline D.L. Diesel Oil "N" SAE 30 after 5500 hours of service in your De La Vergne Diesel Engine.

This product is suitable for further service as evidenced by its extremely low sediment - 0.1% and negligible % ash - 0.002%. As the original oil has a viscosity of 55 seconds at 210° F. a rise of 2 seconds at this temperature is relatively insignificant. The Neutralization No. (acidity) has been unaffected by its length of service.

From a study of this analysis we would recommend the use of this oil for at least another 2500 hours at which time it would be advisable to have the oil analyzed again.

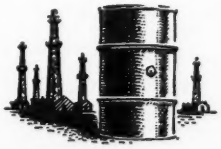
Yours very truly,

A.J.Zino

Anthony J. Zino, Jr.
Asst. Mgr.Lubrication

AJZ:MRS
cc
Mr. G.W.Pressell
Mr.H.E.Sanson
Mr.F.M.White
Mr.A.Zino

Reproduced above are the actual reports made by E. F. Houghton & Co. to a Diesel oil customer. This report was made on oil taken from the crankcase of a De La Vergne Diesel after the oil had been in service for 5,500 hours.



THE OIL

We are advised by the E. F. Houghton Co. that the oil used in this engine was Motoline D. L. Diesel Oil "N" (S. A. E. 30) which is a specially treated Diesel Lubricating Oil composed of the finest type Petroleum stocks. The base oils are processed with certain selected additive agents which contribute to the film strength, oiliness and corrosion resisting properties. These additives are of the halogenated, aromatic type of organic compounds and they are not affected by "Cranite", the purifying medium of the Honan-Crane Purifier.

5,500 HOURS OF PERFECT LUBRICATION

★ Here is a Diesel Engine running 5,500 hours and every minute of it on clean fresh oil. The Honan-Crane "Continuous" Oil Purifier removes all types of contamination as fast as they are liberated. This engine operated these 5,500 hours with a minimum amount of wear on moving parts which means less maintenance, longer engine life and lower operating costs.

The Life of the Oil—the above report advises another 2,500 hours of further use and then another checkup. That is 8,000 hours and many, many more. Good oil, *properly purified,* just doesn't wear out.

If you are not getting these kind of results from your Diesel Lubricating Oil—you owe yourself a little checkup—Write today for Bulletin 100M on Lubricating Oil, and also Engineering Bulletin on Purification of Diesel Fuel Oils.

THE PURIFIER

The Honan-Crane "Continuous" Oil Purifier gives you perfect protection against contamination in Lubricating oil. It is direct connected and continuous in operation which means that the contamination is removed as fast as it is liberated.

It has "Cranite" as a purifying medium, which is a special processed combination of Fuller's earths that will remove all types of contamination. The efficiency of design gives very low operating costs.

HONAN-CRANE CORPORATION

301 INDIANAPOLIS AVE.
LEBANON, INDIANA
RESIDENT ENGINEERS IN PRINCIPAL CITIES

One-Man Operation Helps Solve Man-power Problem In Power Plants

Every Roto Tube Cleaner you put to work in your plant enables you to release one man for other productive work. A simple air valve on the Roto motor permits one man to operate the cleaner entirely by himself. This not only saves a helper, but eliminates delays caused by having to signal the helper to turn air off and on between every tube cleaned. The powerful Roto motor and keen cutter heads make short work of hard scale or soft, gummy deposits. Roto offers a wide variety of air- and water-driven cleaners for any cleanable tube from 1/2" to 12" I.D. Leading power plants enjoy the time- and labor-saving features of Roto Tube Cleaners. How about yours? Write today.

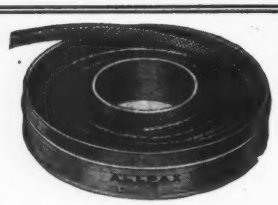
Roto Model 130 air-driven motor with swing-frame head and air valve for one-man operation in 3¼" curved tubes.

WRITE FOR DETAILS

The **ROTO** Company

145 Sussex Ave., Newark, N. J.

ROTO Tube Cleaners



ALLPAX

THE PACKING THAT "PACKS ALL"

. . . use it once and

. . . you'll use it always

THE ALLPAX CO., INC.

Mamaroneck, N. Y.

•

Distributors Everywhere

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

way he was a leader in the gradual transition from the revolving-armature, smooth-core machines to modern deep-slot, revolving-field machines of tremendously increased ratings.

William E. Tomlin

WILLIAM E. TOMLIN, 73, a power plant engineer, died at his home in Leavenworth, Kansas, May 6th. Mr. Tomlin was born in Platte County, Missouri, and after finishing his education, went to Leavenworth and became engineer for the Kansas Electric Power Co. He was also engineer for the Abernathy Furniture Manufacturing Co. (Kansas City and Leavenworth), and was associated with this company at the time of his death. He is survived by his wife, one daughter and one son.

MANUFACTURERS' PERSONALS

The Cooper-Bessemer Corp. has just announced the appointment of Carl H. Vaupel to the position of assistant general manager, applicable to the company's two plants, one at their Mount Vernon, Ohio, headquarters and the other at Grove City, Pa.

E. D. Dickinson, Designing Engineer of the Turbine Engineering Division of General Electric's Lynn River Works, has retired after 43 years of service with the company. His retirement was effective May 31, 1943. At the time of his retirement, Mr. Dickinson was the oldest turbine engineer in the General Electric Co., both in age and service, and had a longer service record in turbine engineering than any other engineer in active service in the world today.

In the early steam turbine days part of Mr. Dickinson's job was to start the turbines running and keep them running. He was sent to Chicago to put into operation the first 5000-kw turbine which was installed at the Commonwealth Edison Co. He was instrumental in the formation for G.E. of the Turbine Construction Department, now the Service Engineering Division.

K. M. Holt has been appointed Executive Engineer, A. D. Somes has been appointed Assistant Engineer, and F. C. Linn, Designing Engineer of the Turbine Engineering Division of General Electric's Lynn River Works. The appointments, announced by G. M. Stevens, Works Manager, were effective June 1. Mr. Holt succeeds E. D. Dickinson, who retired as of May 31.

James G. Gammel has been promoted to the position of technical assistant in brush engineering service of The Osborn Manufacturing Co. Mr. Gammel will assist G. O. Rowland who spends much of his time in Washington as chief of WPB's industrial brush unit.

W. A. Yost, Jr., has been appointed manager of the marine division of the steam turbine department of Allis-Chalmers Mfg. Co. Mr. Yost formerly was manager of the turbine department of the Elliott Company. In his new position, Mr. Yost will have charge of the greatly expanded production of marine propulsion and auxiliary generating equipment which Allis-Chalmers is providing for many types of Navy ships and for the U. S. Maritime Commission's Victory ship program.

No. 4 in a series of tributes to America's War Industries

FIGHTING EAGLES RULE THE ROOST

Suddenly, with a raging roar, a pack of sleek, hungry hunters hurtle out of the sun and pounce on their favorite prey—the Luftwaffe. They're the newest American fighter planes . . . and it's no wonder Goering's "finest" hesitate to mix it up with them. Piloted by the best flyers in the world, they're as fast as lightning and they hit like thunderbolts . . . they fight like wildcats and they're as deadly as cobras.

Such planes are the result of the miracles worked by American industry in catching up with enemy fighter plane developments . . . and then passing them! The fact that they are now going out *en masse* to every fighting front is a vivid testimonial to the outstanding production achievement that has made them possible.

The fighter plane was perhaps the toughest nut to crack. But all along the line . . . tanks, ships, guns, bombers . . . there were knotty problems that were straightened out, overcome, because of the skill and the will, the brains and the brawn of American industry.

IN PLANTS OF ALL TYPES

TODD BURNERS

ARE WORKING FOR VICTORY

Wherever trouble-free, dependable combustion of liquid and gaseous fuels is a necessity . . . in war plants, in countless merchant and fighting ships . . . Todd Burners are delivering unsurpassed performance in the production of heat and power.

TODD SHIPYARDS CORPORATION

TODD COMBUSTION DIVISION

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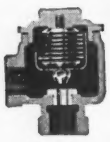
TODD BURNERS ★ ★ ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT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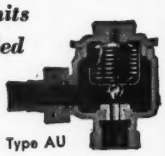
★ *No Water Logged Units*
★ *No Adjustment Needed*
★ *No Air-Binding*
★ *No Freeze-Ups*
★ *No Dribbling*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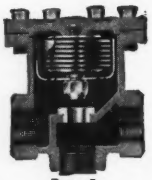
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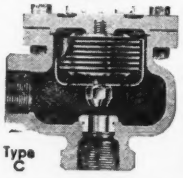
Type C

5 BIG ADVANTAGES OFFERED USERS OF NICHOLSON *Thermostatic Industrial* **TRAPS**

All types drain completely and automatically . . . same adjustment used for any pressure, vacuum to maximum allowable . . . discharge air as efficiently as water . . . complete drainage when cold prevents freezing . . . closes immediately when steam contacts bellows. Five types, sizes 1/4" to 2', pressures up to 300 lbs. Bulletin No. 242.

Also

INVESTIGATE THE ADVANTAGES OF INSTALLING THESE OTHER NICHOLSON SPECIALTIES

Super-Pressure Piston and Weight Operated Traps

Compressed Air and Gasoline Traps

Steam Eliminators

Steam Separators

Welded Floats

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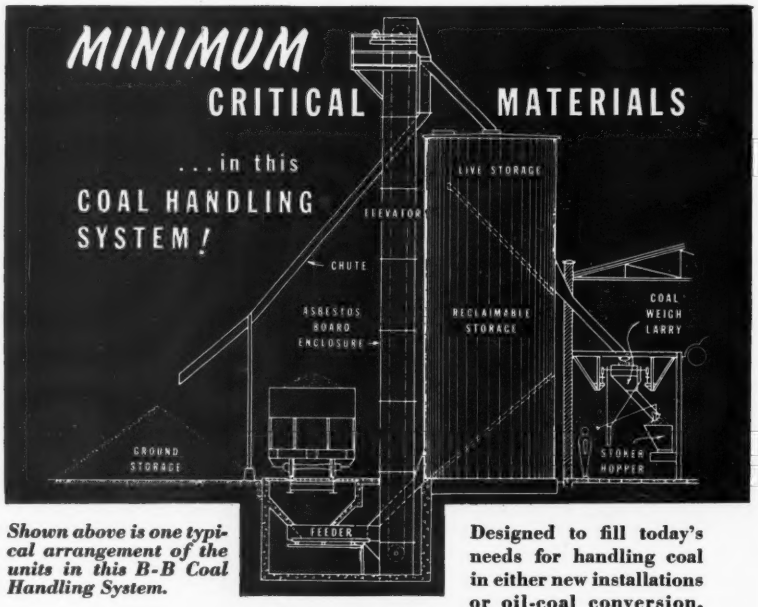
W. H. NICHOLSON & CO., 160 OREGON ST., WILKES-BARRE, PA.

NICHOLSON *Traps*

THERMOSTATIC ▼ PISTON AND WEIGHT-OPERATED STEAM GASOLINE AND COMPRESSED AIR TRAPS

CONTROL VALVES ▼ FLOATS ▼ MANDRELS ▼ STEAM AND AIR SEPARATORS

MINIMUM CRITICAL MATERIALS . . . in this COAL HANDLING SYSTEM!



Shown above is one typical arrangement of the units in this B-B Coal Handling System.

Write us today for complete details.

Designed to fill today's needs for handling coal in either new installations or oil-coal conversion, this system offers numerous advantages. Send for full information.

BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.

MANUFACTURERS AND ERECTORS OF COMPLETE COAL AND ASH HANDLING SYSTEMS

David MacGregor has been appointed chief engineer of The Edward Valve & Mfg. Co., Inc., East Chicago, Ind. Mr. MacGregor has been associated with the company in various engineering capacities since 1925.

J. C. Mahoney, superintendent of the turbine and marine installations section of General Electric Co.'s Service Engineering Division since 1922, retired on June 1, according to an announcement by W. M. Denny, manager of the Division. Mr. Mahoney has been succeeded by T. W. Howard who has been his assistant since 1920.

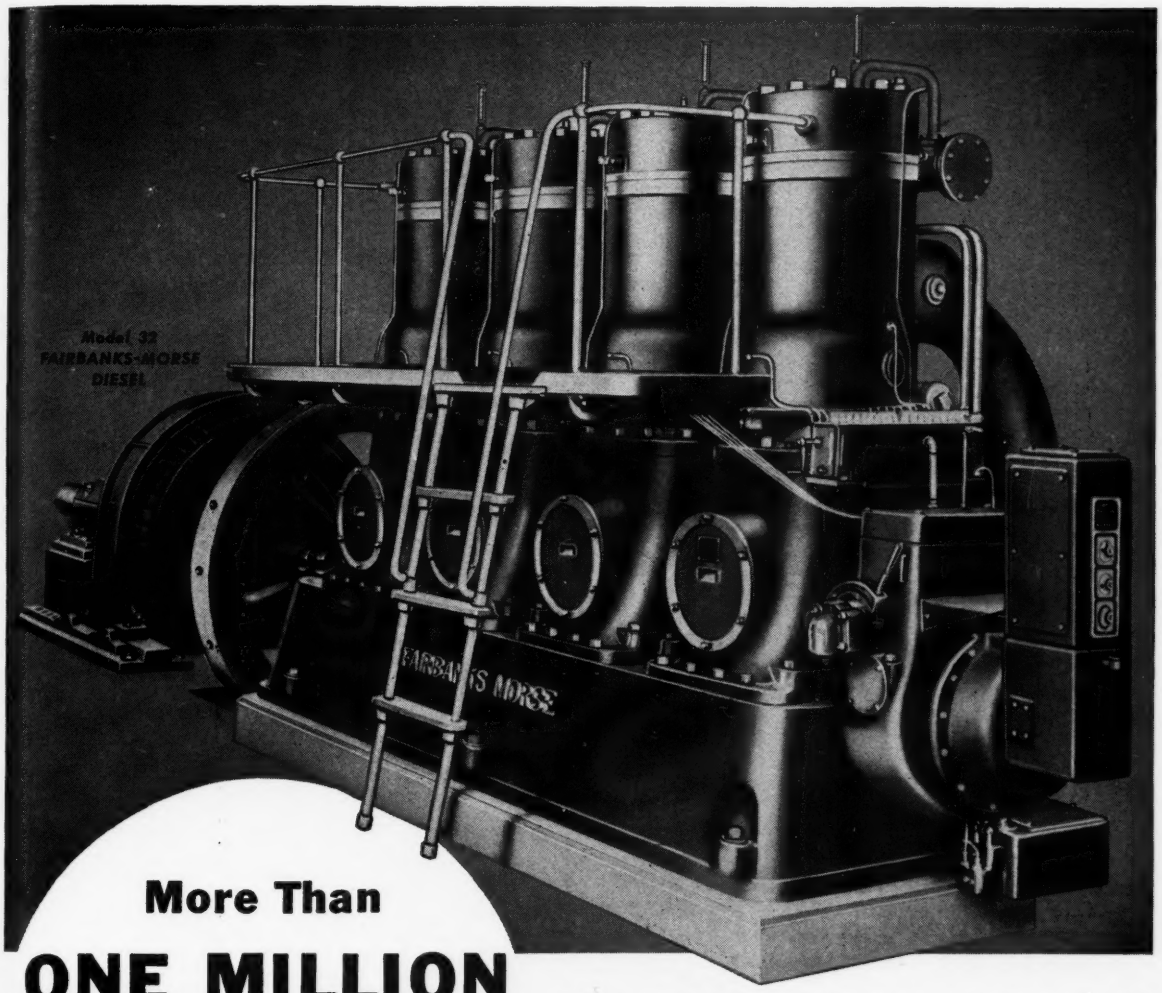
Roy L. Stone, with offices in Rochester and Buffalo, N. Y., has recently been appointed flow meter representative of Cochrane Corp. in the Western New York territory. His organization also handles Hays combustion controls and Reliance gage columns.

Horace P. Liversidge, president of the Philadelphia Electric Co., announced the election of John A. Diemand, Walter D. Fuller, and Edward Porter to the board of directors of the company to fill vacancies caused by the death of John E. Zimmerman and the resignation of W. W. Bodine and Walter E. Long.

Marcello A. King has joined the Worthington Pump and Machinery Corp. organization as Executive Engineer of its Moore Steam Turbine Division, Wellsville, New York, in charge of design, research, testing, and service. Since his graduation from the University of Michigan in 1916, he has been engaged in turbine engineering and manufacture, having been associated with the Kerr Turbine Co. and later with the Elliott Co., where he held the position of Manager of Engineering.

Dewey C. Harvey has been promoted to the post of chief plant engineer of the Osborn Manufacturing Co., Cleveland, Ohio. Prior to joining the Osborn company in 1935, Mr. Harvey served in the engineering departments of Peerless Motor Co., C. O. Bartlett & Snow Co., and The Bender Body Co. Shortly after finishing his schooling in Cleveland, he went overseas as a member of the U. S. Marines during World War I, where he was awarded the Purple Heart medal for conspicuous bravery in action. As head plant engineer covering both the brush and moulding machine divisions of the Osborn company, Mr. Harvey will have charge of new construction and plant maintenance, including power plant operations, and will also superintend the installation of new machinery at the factory and home office.

Edgar C. Brandt has been elected a member of the Board of Directors of Elliott Co. and vice-president in charge of manufacturing. Mr. Brandt comes to the Elliott Co. after 38 years of experience with Westinghouse Electric and Manufacturing Co. He started with an engineering course in 1905 and came up through the organization to sales manager of renewal parts and maintenance for the entire company. He has also served the War Production Board for the past two years.



More Than ONE MILLION *Installed Horsepower* Behind This Engine

Extreme simplicity achieved by eliminating all but essential moving parts . . .

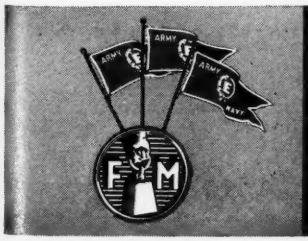
High combustion efficiency resulting from advanced cylinder and head design . . .

Improved injection valve and new design of scavenging air ports to produce complete back-flow scavenging . . .

These are the three outstanding improved features which give Model 32 Fairbanks-Morse Automatic Scavenging Diesel top rating among experienced users of stationary power.

Two fundamental principles are responsible for the extreme simplicity of this Diesel: (1) two-cycle design; (2) airless injection of fuel. These two factors, combined with the crankcase scavenging principle reduce the number of moving parts to the minimum.

A bulletin containing complete details on the construction and operation of Model 32 will be furnished upon request without cost or obligation. Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago. Branches with service stations throughout the United States and Canada.



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DIESEL ENGINES
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MOTORS
GENERATORS
SCALES
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FARM EQUIPMENT
STOKERS
AIR CONDITIONERS
RAILROAD EQUIPMENT

F M Diesels

Win Today's Battle Against

with

ECLIPSE METAL HOSE

Its deep, parallel sidewall corrugations combine maximum flexibility with lasting toughness—makes Eclipse Seamless Metal Hose the logical low-cost material for Diesel exhausts and for handling all kinds of liquids or gases where vibration and expansion are present.

Eclipse Metal Hose withstands high pressure and temperatures. Monel hose is stocked in sizes ¼ in. to 2 in. I.D.; steel hose can be produced up to 40 in. I.D. Write us about your problems of conveying non-solids, non-abrasives. Ask for descriptive bulletin.

THE INVISIBLE CREW
Precision Equipment by **Bendix**
Dept. 19—Phila. Div.—Philadelphia, Pa. AVIATION CORPORATION

For

LOW COST
LEAKPROOF
HANDLING OF

OILS
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Etc.

ECLIPSE

Swartwout Controls

help you keep vital power service flowing

with Safety, Efficiency and Economy

FOR MANY YEARS, Swartwout customers have found they can depend upon the design, engineering and construction of Swartwout Controls for unusually reliable service under toughest power plant conditions. Today's developments in these products add extra safety and efficiency, with low maintenance features that mean economy in time and money. ...Swartwout standards have always been high; Swartwout progress continues to embrace the latest techniques, materials and processes. Cooperation with your consulting engineer is complete, and special adaptations are made to fit their interpretation of your needs.

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Power Plant Equipment

Feed Water Regulators
Pump Governors
Liquid Level Controls
Pressure Control Valves
Desuperheaters
Desuperheater Governors
Differential Pressure Master Regulators
Feed Water Heaters
Drainage Systems
Steam Separators
Air Separators
Exhaust Heads

•

UNIT RESPONSIBILITY
Swartwout handles the complete problem of Feed Water Control or of Reducing and Desuperheating, assuring fully satisfactory results.

MANUFACTURERS' NEWS

Westinghouse Electric and Mfg. Co. has announced that Fred T. Whiting, manager of the company's Northwestern District, with headquarters in Chicago; and Charles A. Dostal, Pacific Coast District Manager, with headquarters in San Francisco, have been elected vice-presidents of the company. Duties and headquarters of both men are unchanged.

Wininger & Selby, Inc., Ten Rockefeller Plaza, New York City, whose officers have been in the construction business during their entire business careers, has purchased control of The Nicholson Co., Inc., for the past 29 years engaged in the design, construction and equipment of concrete storage bins and tanks for the storage and handling of coal and other granular and liquid materials. The officers are: S. Edward Wininger, president; Paul N. Rylander, vice-president; Cliff Scott secretary; Charles A. Selby, treasurer.

The Williams Gauge Co., 3000 Pennsylvania Ave., Pittsburgh, Pa., announces the appointment of two new representatives for the Salt Lake City territory. William H. Saylor and H. E. Barsford of the Specialty Sales Co. in that city will represent the Williams Gauge Co. in southern Idaho, eastern Nevada, southwestern Wyoming, and the state of Utah.

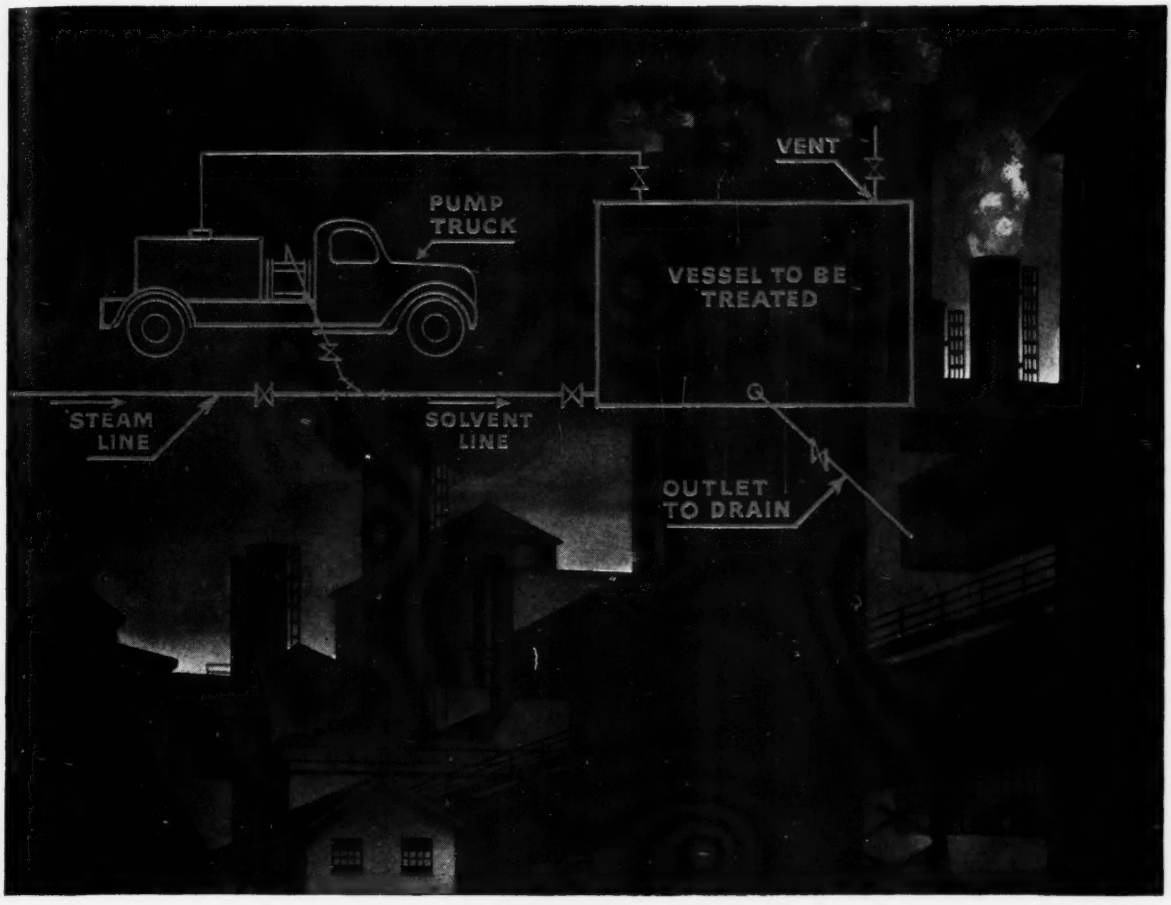
The Metrol Co. has been appointed by the Cochrane Corp., Philadelphia, as flow meter representatives for the Detroit territory. Metrol Co. is located at 2970 West Grand Blvd., Detroit, and will also handle Hays combustion control and instruments, Reliance gage columns and Wilson tube cleaners.

Metrol Co. is headed by Robert A. Wright whose ten yr experience with these products gives him a good background of training and experience. Associated with him will be Warren W. Wassall, who for the past 20 yr has been connected with the Laclede Stoker Co., having served since 1936 as their general manager.

Cochrane Corp., Philadelphia, announce the appointment of Bushnell Controls & Equipment Co. for the direct sale of Cochrane Flow Meters in California, Western Nevada and Arizona.

C. C. Moore & Co. Engineers, Inc., Pacific Coast Representatives for Cochrane Corporation, continue to handle all Cochrane products including Flow Meters in Oregon, Washington, British Columbia, Alaska, and all Cochrane products excepting Flow Meters in California, Nevada and Arizona.

Canton Stoker Corp., Canton, Ohio, announces the appointment of the following organizations and representatives as district managers: S. S. Fretz, Jr., Inc., 1902 Chestnut St., Philadelphia, Pa.; M. T. Gossett Co., 101—16th St., Nashville, Tenn.; Lang Co., 267 West First St., South, Salt Lake City, Utah; Manhattan Boiler & Equipment Co., 80 Water St., New York, N. Y.; Morris Engineering Co., 813 N. Calvert St., Baltimore, Md.; The Pease Co., 488 Glenbrook Road, Stamford, Conn.; The Perkinson Co., 151 E. Post Road, White Plains, N. Y.;



HERE'S THE HOOK-UP

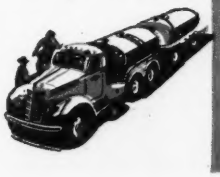
FOR IMPROVED PLANT EFFICIENCY—LESS SHUT-DOWN TIME

The above diagram shows one of the typical hook-ups for Dowell Industrial Cleaning and Scale Removal treatments. After scale samples have been analyzed by chemical, X-ray, spectrographic or solubility methods, the solvents required for dissolving the water-deposited scale are transported to the vessel to be cleaned by special automotive pumping units.

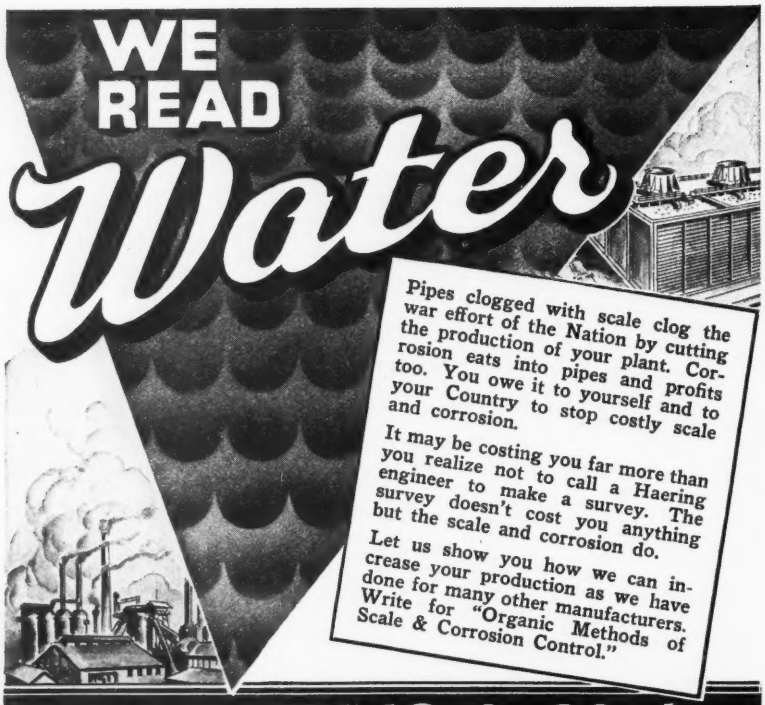
Pumps are used to circulate the scale dissolving solutions, throughout the entire vessel, for a predetermined period. Accurate records—such as solvent concentration, temperature readings, pumping rates and corrosion control observations—are made throughout the treatment.

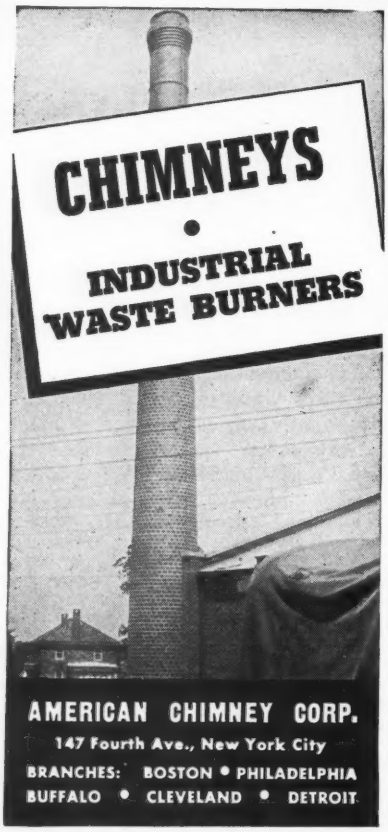
This safe, fast and economical chemical method dissolves or disintegrates water-deposited scale and sludge from *all* types of heat exchange equipment including boilers, condensers, feed water heaters, cooling jackets, water lines—all types of vessels that contain scale depositing fluids. Write for special literature.

DOWELL INCORPORATED
Kennedy Bldg., Tulsa, Oklahoma
Subsidiary of The Dow Chemical Company



Look to
DOWELL
FOR INDUSTRIAL CLEANING AND SCALE REMOVAL SERVICE


WE READ
Water
Pipes clogged with scale clog the war effort of the Nation by cutting the production of your plant. Corrosion eats into pipes and profits too. You owe it to yourself and to your Country to stop costly scale and corrosion.
It may be costing you far more than you realize not to call a Haering engineer to make a survey. The survey doesn't cost you anything but the scale and corrosion do.
Let us show you how we can increase your production as we have done for many other manufacturers. Write for "Organic Methods of Scale & Corrosion Control."
D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive Chicago, Illinois.



OUR MEN NEED
★ BOOKS ★
SEND
ALL YOU CAN SPARE
That book you've enjoyed—pass it along to a man in uniform. Leave it at the nearest collection center or public library for the 1943 VICTORY BOOK CAMPAIGN.

Reamer Industries, Inc., Seaboard Park, Columbia, S. C.; M. A. Rufe Estate, Doylestown, Pa.; John L. Underwood, 139 Edgewood Ave., Atlanta, Ga.; Debro, Inc., 318 Summit St., Toledo, Ohio.

The Coal Bureau of the Upper Monongahela Valley Association has added Edmund McCarthy, Fuel Engineer of New York City, to its technical staff. The major part of Mr. McCarthy's work will be cooperating with industrial consumers, consulting engineers and equipment manufacturers in connection with oil conversions, equipment design and coal application. Mr. McCarthy is a graduate Mechanical Engineer and a licensed Professional Engineer with a background of 23 years' experience in the fuel engineering field, both in bituminous and anthracite coals.

Army-Navy "E" Awards
The Babcock & Wilcox Co.*
Augusta Works
DeLaval Steam Turbine Co.*
Trenton, N. J.
Philadelphia Gear Works, Inc.
Philadelphia, Pa.
Sylvania Electric Products, Inc.*
Emporium, Pa., plant
Maritime Commission "M" Award
Homestead Valve Manufacturing Co.*
Coraopolis, Pa.

*Added star for sustained high achievement in production of war equipment.

NEWS FROM THE FIELD

Dr. Slepian Gets Lamme Medal

DURING the five-day national technical meeting of the AIEE in Cleveland, Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories, was presented the Benjamin Garver Lamme Medal, awarded annually by the American Institute of Electrical Engineers for meritorious achievements in development of electrical apparatus or machinery. Dr. Slepian, one of the nation's leading mathematicians and physicists, was selected as the 14th winner of the Lamme Medal for his contributions to the development of current interrupting and current rectifying apparatus. He developed the Ignitron, an electronic tube now being used in aluminum and magnesium plants to convert alternating electric current into the direct current required for production of those metals. The Westinghouse scientist is also noted for his work on circuit breakers, the automatic electric switches that snuff out electric arcs in power systems. His first major circuit breaker invention was the Air De-ion grid, a magnetic device that cuts a long electric arc into short pieces which are

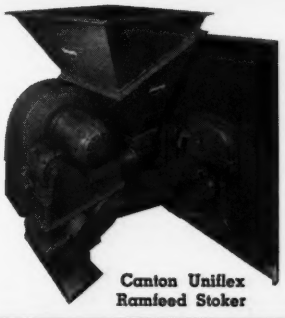
CANTON STOKER INSTALLATIONS ARE *Double* CONTRIBUTIONS TOWARD VICTORY . . . . .

HUNDREDS OF "FAMOUS NAME" PLANTS RELY ON CANTON STOKERS . . . .

Bell Aircraft Corp., Republic Steel Corp., General Motors Corp., and Black & Decker, are just a few of the many prominent organizations who after careful analysis chose CANTONS — numerous repeat orders throughout this list indicate the high degree of satisfaction.

54 STOKER TYPES AND SIZES TO MEET VARYING STRUCTURAL CONDITIONS AND COAL BURNING NEEDS

• Because conversions quite frequently present problems of space and vital time loss, numerous CANTON installations were the result of the ability to successfully meet unusual requirements. With both Wormfeed and Ramfeed Stokers engineered for applications up to 800 H.P. and more, CANTON offers a most complete line. The illustrations above are of CANTON Lo-Set Ramfeeds with Uniflex drives; advantages include rapid time-saving installation, all operations in the front, shallow floor level ashpits, and front motor mountings—ideal for limited space. High overload capacities and low maintenance and steam costs can always be counted on from CANTONS. May we send you all the facts today? Use the coupon now.



Canton Uniflex Ramfeed Stoker

★ ★ ★

ALL "CANTONS" GUARANTEED 5 YEARS AGAINST DEFECTS AND WEAR AS WELL

CANTON STOKER

• Exclusive with CANTON is this 5 year Bond—only CANTONS' rugged and durable construction could make possible this guarantee against DEFECTS and WEAR as well.

32 YEARS OF "KNOW HOW"

CANTON STOKER CORPORATION

900 Andrew Place, S. W., Canton, Ohio

GENTLEMEN:

.....Please send all descriptive literature at once.

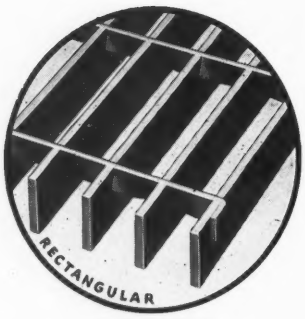
.....Have a CANTON Engineer interview us immediately.

Name.....

Company.....

Address.....

City.....*State*.....



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TRI-LOK
OPEN STEEL FLOORING
CONCRETE ARMORING
SAFETY STEPS
T. TRI-LOK
Full descriptive catalog of Tri-lok Grating, Safety Treads and other products on request.

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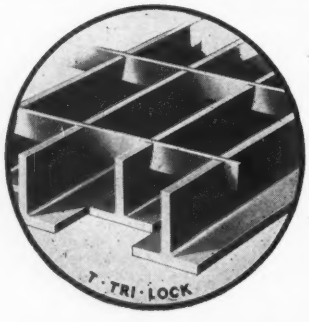
300 PENN AVENUE, PITTSBURGH, PA.
REPRESENTATIVES IN PRINCIPAL CITIES



easily extinguished. He also developed improved lightning arresters to protect power system equipment.

Joint Fuels Conference

ANNOUNCEMENT has been made of a Joint Fuels Conference of the American Institute of Mining Engineers and American Society of Mechanical Engineers to be held at the William Penn Hotel, Pittsburgh, Pa., on Thursday and Friday, October 28 and 29.

A General Committee established by representatives of the two associations consists of T. E. Purcell, Chairman, H. F. Hebley, L. E. F. Wahrenburg, A. W. Thorsen, T. J. Barry, and H. P. Greenwald. The group, already at work to insure the success of this timely and important conference, has appointed several subcommittees headed by the following chairmen: T. J. Barry, Arrangements; Martin A. Mayers, Program and Papers; M. R. McConnell, Inspection Trips; J. T. Ryan, Jr., Publicity; G. A. Shoemaker, Hotel and Registration.

Annual Water Conference at Pittsburgh

THE ENGINEERS' SOCIETY of Western Pennsylvania will hold its Fourth Annual Water Conference in the William Penn Hotel, Pittsburgh, Pa., on Monday and Tuesday, November 1 and 2, 1943. H. M. Olson is general chairman of the Conference.

Annual Meeting of the American Welding Society

THE AMERICAN WELDING SOCIETY will hold its twenty-fourth annual meeting during the week of October 18, 1943, in the Hotel Morrison, Chicago, Illinois. E. V. David is chairman of the Convention Committee.

Stock-piling of Critical Materials Part of A.I.M.E. Post-War Plan

IN ITS CURRENT DISCUSSIONS of post-war planning for the mineral industries, the American Institute of Mining and Metallurgical Engineers includes a proposal for stock-piling of critical materials during and after this war to aid in preventing the acute shortages of materials we now experience and for a number of other reasons. A resolution advocating that Congress take some action on this matter has been presented to the board of directors of the A.I.M.E. which has published it for discussion in Mining and Metallurgy.

The resolution as proposed urges the passage of appropriate legislation by Congress for the provision of funds to accumulate adequate stock piles of critical minerals during the period of 10 yr immediately following the termination of the present war, with the understanding that the material in such stock piles shall, under no consideration, be used except during a future war and except to the extent that changing technology shall destroy the indispensability of one or more of the minerals in reserve stock piles.

Commenting on the resolution, A. B. Parsons, Secretary of the Institute and editor of Mining and Metallurgy, says: "The reason for suggesting that an appropriate law be enacted promptly is the simple one that the public and Congress are, today, acutely conscious of

The Problem of the 225 p. p. m.

From ILLCO's Case Book of Boiler Feed-Water Treatment . . .

A LARGE PUBLIC UTILITY needed more equipment. Expansion prompted it to find out if there was a better method of water treatment for its boilers (both low and high pressure type). Previously, it had operated with two older and accepted types of treatment. Various concerns were called in, including the Illinois Water Treatment Company.

THE UTILITY'S RAW WATER SUPPLY contained 225 parts per million of dissolved solids, of which 161 p.p.m. were scale-forming. The amount of make-up water required was 32,000 gallons per hour, 24 hours a day.

COMBINATION-REGENERATION equipment was recommended by ILLCO. This consisted of three reactor tanks (9 ft. diameter, 7 ft. high), containing ion-exchange material to be *regenerated simultaneously with salt and acid*—a process pioneered by ILLCO and which has demonstrated its excellence for over five years in leading industrial plants.

PRODUCING THE REQUIRED MAKE-UP of 32,000 gallons per hour of water free from scale-forming solids and having a total dissolved solid content of less than 40 p.p.m., this unit and this method provided the ideal solution.

NOTEWORTHY ADVANTAGES: Lower dissolved solid concentration in the boiler water, therefore fewer blow-downs and a saving of fuel. Less supervision: only attention required is periodic regeneration. Even when raw water supply varies, quality of treated water is maintained. On comparative cost of chemicals alone, equipment will pay for itself in less than four years. Other operating expenses also greatly reduced—less fuel consumption, lowered maintenance, etc.

WITHOUT OBLIGATION we'll gladly make a similar survey of *your* boiler feed-water problem, suggest recommendations, describe our equipment in detail.

Also engineered and manufactured by ILLCO are De-ionizing Units, Softeners, Filters, Aerators, Chemical Processing Equipment, etc. Write for literature.

TESTED IN THE LABORATORY · ILLCO-WAY · PROVED IN THE FIELD

ILLINOIS WATER TREATMENT CO.
850 Cedar Street, Rockford, Illinois

USERS TELL US,

"POWER LOSS IS NO PROBLEM WHERE TRANSMISSION IS THRU PHILADELPHIA SPEED REDUCERS"

There are two reasons for the high power transmission efficiency of a Philadelphia Speed Reducer installation.

First, because we make all types of reducers, you get the one best suited to the particular need.

Second, all are designed and constructed to assure smooth running, with friction held to a minimum.

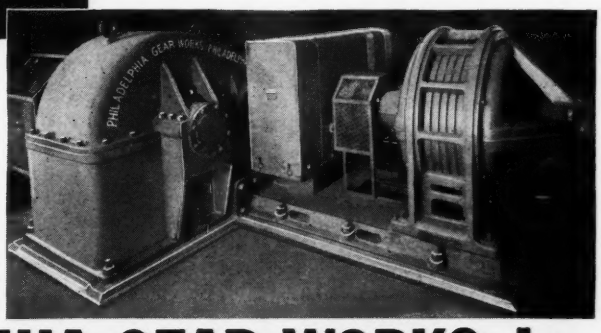
Housings are adequate to provide proper heat dispersal. Lubrication systems also aid efficient, trouble-free operation.

Tell us your requirements... we'll gladly recommend the right types of units to meet them.

Vertical MotoReduceR

Philadelphia Planetary Speed Reducer

A Philadelphia Herringbone Reducer installed in a grain elevator

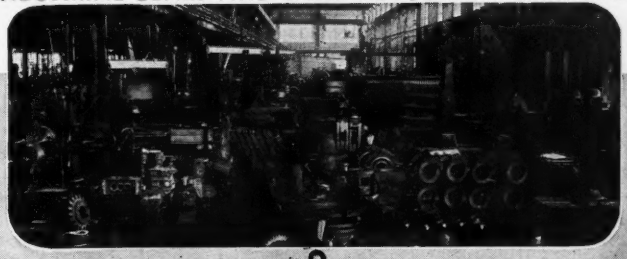


ARMY NAVY

PHILADELPHIA GEAR WORKS, Inc.

INDUSTRIAL GEARS AND SPEED REDUCERS LIMITORQUE VALVE CONTROLS

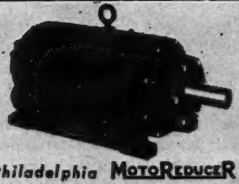
ERIE AVENUE & G STREET
PHILADELPHIA 34, PENNA.
NEW YORK, PITTSBURGH, CHICAGO



Philadelphia **LIMITORQUE CONTROL** operates all types of valves, etc., safely, economically, from convenient stations.

Philadelphia **GEARS** All types and sizes of industrial gears. Can be supplied in all materials.

Philadelphia **HERRINGBONE SPEED REDUCER** for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.



Philadelphia MOTOREDUCER The economical self-contained drive. Horizontal or Vertical types — various ratios and horsepowers.

Philadelphia **WORM GEAR SPEED REDUCER** right angle drives — vertical or horizontal. Wide range of ratios and horsepowers.

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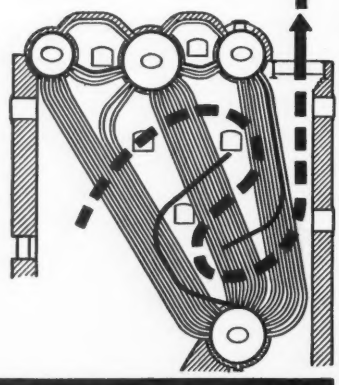
Extra Power Quickly

...and easily... with these Fuel-Saving Baffles

- Provide cross-flow of gases over tubes for maximum heat-transfer
- Tapered gas passes and curved surfaces streamline the gas flow and maintain gas velocity for efficient heat-extraction
- Draft losses materially reduced by elimination of eddy currents, bottlenecks and dead gas pockets
- Less steam used in cleaning because soot blowers are used less often, and more effectively
- Applicable to any design of water-tube boiler, fired by any fuel
- Each installation is designed on the basis of 25 years experience in this specialized branch of engineering
- Installed by skilled mechanics

Ask for bulletin BW 40 giving valuable data on modern baffle-wall constructions — free



THE ENGINEER CO.
Enco 75 West St. New York, N.Y.

the indispensability of these minerals and of the possibility that normal channels of supply may be disrupted in time of war. No one, of course, expects during the present war to accumulate stock piles for future use; but unfortunately human nature is such that legislation aimed against future conflagrations is much more easily passed when a fire is raging than after it has been extinguished. Immediately after the war of 1914-18, many farseeing people, like Bernard Baruch, began urging immediate steps to provide adequate supplies of essential strategic minerals for a future war; but nothing of any consequence in the direction of stock-piling was authorized by Congress until June 1940!"

It is estimated that an adequate program of stock-piling would involve materials valued at $3,000,000,000 or more. Such amount, however, would not necessarily have to be appropriated. At the end of the war the Government will own vast quantities of raw, partly processed and fully manufactured materials containing critical minerals that in one way or another could be converted into form for stock-piling. The alternative would be to dump huge tonnages of this material on an industrial market already oversupplied. Furthermore, quantities of critical materials from foreign sources could be obtained in exchange for food or manufactures that for reasons of expediency might otherwise be given without compensation.

Brazilian Aluminum Industry Installs G-E Apparatus

THE FIRST GENERATORS and transformers for power stations which will generate 6000 kw of power for Brazil's new aluminum industry are now being installed.

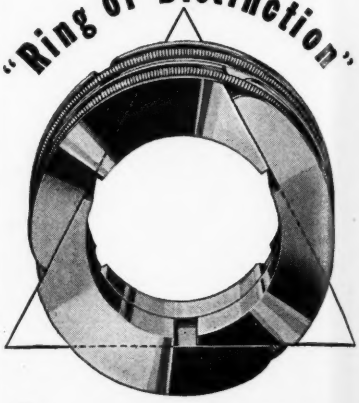
When, in 1940, the 1600-odd tons of aluminum which Brazil imported annually from the United States was cut off by the enormous demands of American aircraft industry, the Brazilian government laid plans to speed development of its 81 known deposits of bauxite estimated to contain approximately 150,000,000 tons. The state of Minas Geraes alone contains an estimated 120,000,000 tons and a Brazilian concern, Eletro Quimica Brasileira, made plans to enlarge its power facilities at three points —Saramenha, Caboclo and Funil—to serve a projected aluminum plant near Ouro Preto, an important center in Minas Geraes.

For Saramenha, where alternating-current power will be received and converted into direct current, the concern ordered four General Electric motor and generator sets, each composed of a 2900-hp synchronous motor and two 1000-kw generators. This apparatus is now being installed. Power will be supplied by both Caboclo and Funil, as well as by other existing stations.

For Caboclo, where installations are nearing completion, two 3000-hp waterwheels have been supplied by the James Leffel and Company of Springfield, Ohio. Under a water head of 86 meters, each will drive G-E generators, power being stepped up by G-E transformers.

Orders have just been completed for the Funil power station, where installations are scheduled for late 1944. Leffel will supply a 2500-hp waterwheel under a water head of 54 meters and I.G.E. will furnish a generator and a transformer.

"Ring of Distinction"



Install FRANCE Metal Packing for "'Round-the-Clock" Production

The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a garter spring having minimum tension.

The result is tight "full-floating", trouble-free performance for years. Prompt delivery assured.

FREE

44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-5, with facts on

- Packing Designs for Any Service
- Installation Procedure
- Methods of Lubrication
- Pressures and Temperatures
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Request France Engineers to analyze your packing requirements. There is a representative close at hand.

THE FRANCE PACKING COMPANY
Tacony, Philadelphia 35, Penna.
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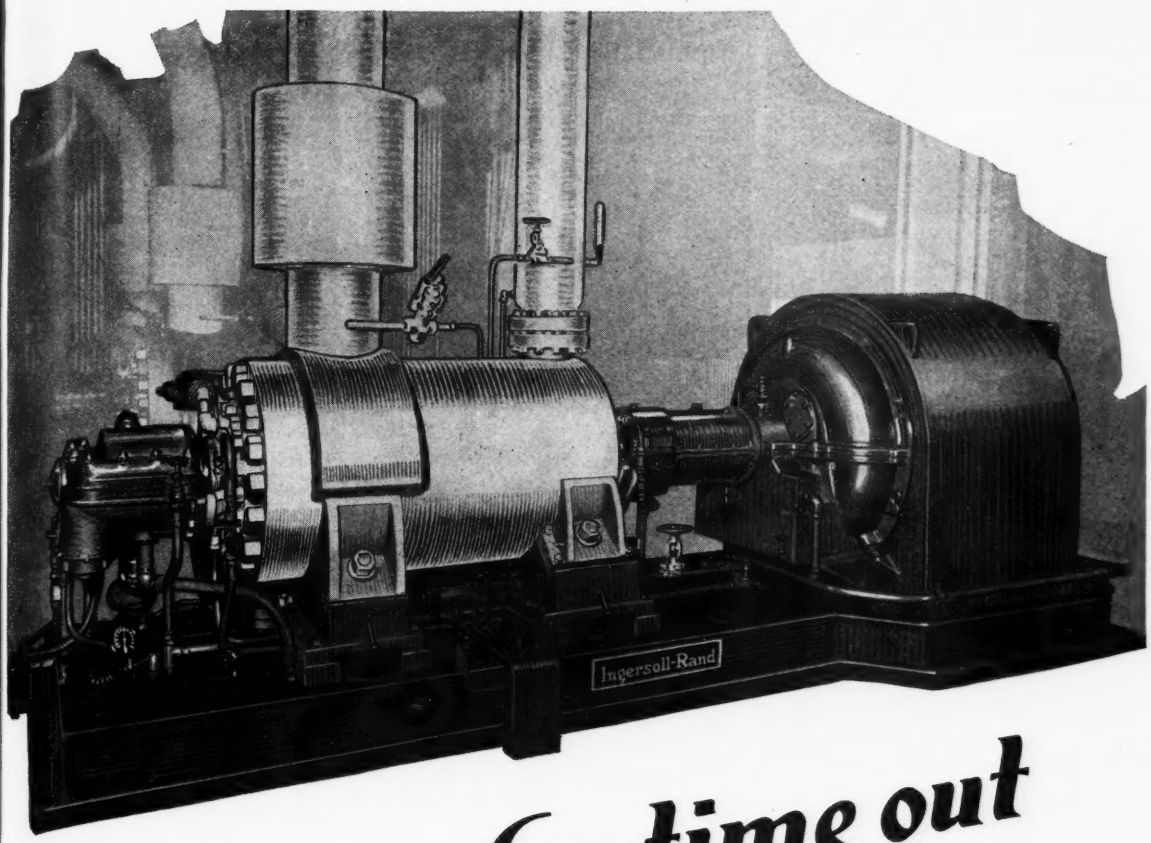
Original FRANCE METAL PACKING



No time for time out

These days the only time that counts is production time. Power plants must supply steam and electricity 24 hours a day. Boiler-feed pumps in these plants have to be good.

Ingersoll-Rand boiler-feed pumps have built up a reputation for dependable operation in all types of plants. There is an Ingersoll-Rand pump for the smallest industrial power plant and for the highest pressure central station. Sizes range from 5 to 2500 horsepower — discharge pressures up to 3000 pounds per square inch. Ingersoll-Rand Company, 11 Broadway, New York, N. Y.

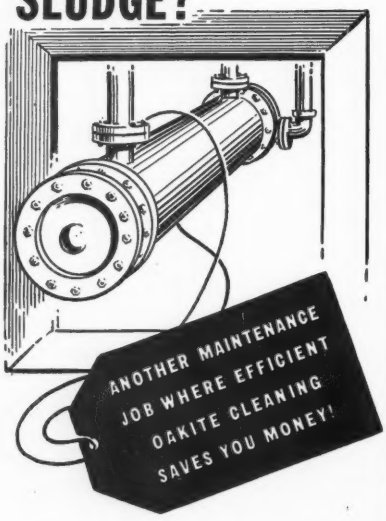
All plants of Ingersoll-Rand Company are flying the Army-Navy "E" awarded "for high achievement in the production of war materials."

Ingersoll-Rand

10-256 *Cameron Pump Division*

CENTRIFUGAL PUMPS • COMPRESSORS • BLOWERS • ROCK DRILLS • AIR TOOLS • CONDENSERS • DIESEL ENGINES

Lube Oil Coolers Clogged with SLUDGE?



Plant superintendents and engineers the country over are finding that sludge-clogged "lube" oil coolers can be easily, quickly cleaned the successful, low-cost Oakite way.

Method is simple. Just circulate solution of recommended Oakite material through system, then rinse. That's all! Sludge and other accumulations are thoroughly, yet safely removed. Heat transfer is restored; lube oil maintained at uniform, proper temperature. And since no dismantling is required, you save time and money . . . units go back in service quickly!

GET THIS BOOKLET!

This 20-page booklet gives more complete data . . . also describes in detail money-saving methods for cleaning and de-scaling Diesel, gas and gasoline engine cooling systems, water-cooled compressors, surface condensers, heat exchangers, etc. It is yours merely for the asking . . . won't you write for FREE copy today?

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23 Thames Street, New York, N. Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE *Specialized cleaning*
Buy Bonds for Victory
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Consolidated Edison Builds Turbine Parts for Navy

BECAUSE it played the dual role of customer and sub-contractor to the same manufacturer, the Consolidated Edison Co. has been able to add a new 50,000 kw power supply to the resources of this city's war industries.

The source of the new electric power supply is a high-pressure steam turbine for which Consolidated Edison itself made some parts, explained J. H. Spraggon, Central Station Manager here for the Westinghouse Electric & Mfg. Co., the manufacturer. The power company produced these parts and assembled the turbine in order to complete the machine when pressure of other war work halted its construction in a Westinghouse plant. By lending a hand, the customer became sub-contractor as well, according to Mr. Spraggon, and thus provided more electrical power for war industries in the New York area.

As a result of this industrial teamwork and because of the high quality of the machining operations Consolidated Edison performed on the spindle of their own turbine, the Westinghouse Company subsequently let sub-contracts to its customer for the machining of turbine spindles, gear cases and bearings, and a volume of detail turbine parts for the Naval shipbuilding program.

Consolidated Edison was able to undertake the delicate task of machining turbine parts because its normal maintenanee operations require a completely equipped machine shop. Regular repair and maintenance work in supplying electric power to New York City requires large lathes, shapers and similar metal-working tools for precision machining. Navy spindles and other parts were machined at Consolidated Edison's New York shops, and were then shipped to the Westinghouse Steam Division plant near Philadelphia, for blading and final assembly into the turbine units that provide propelling power for men-of-war.

Bonneville Power for Two Large Industrial Plants

HYDROELECTRIC POWER from Bonneville, Ore., generating station of Government will be used for power supply for two large industrial developments in that area, with heavy connected loads under maximum production. One of these projects will comprise a mammoth chemical plant in Franklin County, Wash., on site in vicinity of Pasco, to be constructed and operated by E. I. duPont deNemours & Co., Inc., duPont Building, Wilmington, Del., for manufacture of certain war chemicals for Government. Plant will consist of a series of large one and multi-story processing and production buildings, with auxiliary structures for storage, distribution and miscellaneous service. Also, pumping station, machine shop, laboratory, administration building and accessory units. Equipment will be electric-operated. A main power substation will be built for connection with transmission lines of Bonneville system, with a number of transformer stations located at different points on plant site; an electrical distribution will be installed, comprising both underground and overhead lines. Project is reported to cost close to $100,000,000, with financing to be provided by Government. Plans have been approved for a large housing develop-

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- **High-Grade Woven Monel Wire Screen**
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- **Screen and Bushing Come Out Together—Go Back Together, Automatically Aligning**
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- **6 Sizes from ½" to 2" for Pressures up to 600 lbs**
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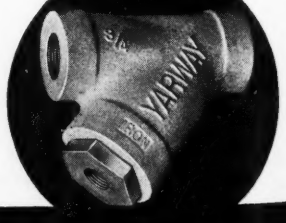
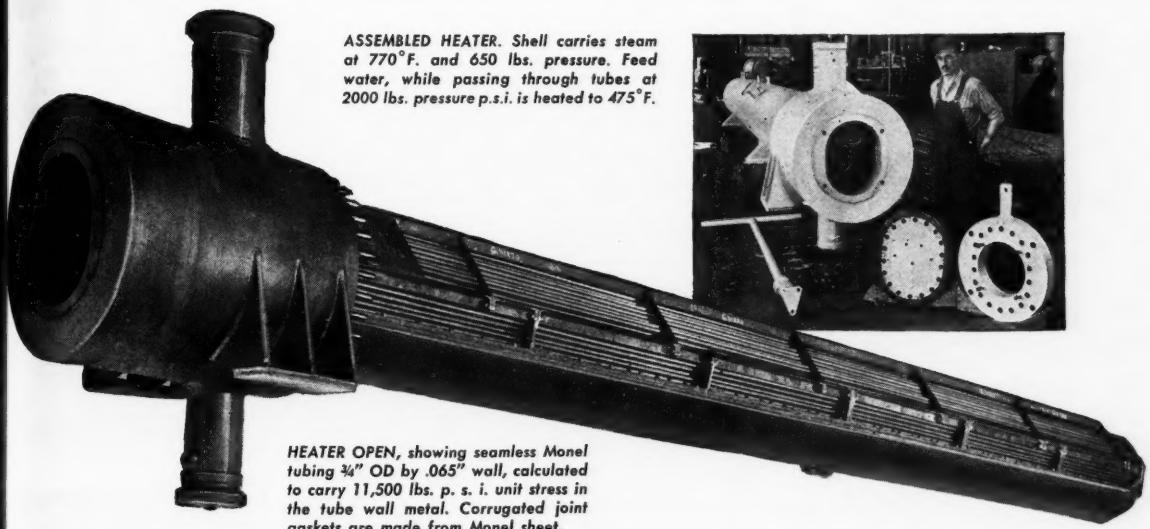


YARWAY STRAINERS

NOT A MOMENT OUT FOR REPAIRS

on MONEL seamless tubing exposed to high pressures and temperatures for two to three years



ASSEMBLED HEATER. Shell carries steam at 770°F. and 650 lbs. pressure. Feed water, while passing through tubes at 2000 lbs. pressure p.s.i. is heated to 475°F.

HEATER OPEN, showing seamless Monel tubing ¾" OD by .065" wall, calculated to carry 11,500 lbs. p. s. i. unit stress in the tube wall metal. Corrugated joint gaskets are made from Monel sheet.

2000-lb. water pressure p.s.i. *inside* . . . steam at 770°F. *outside*.

That's the extremely tough combination met with brilliant success by Monel seamless tubing in boiler feed water heaters, built by the Griscom-Russell Co., New York, N. Y., for the Oswego Station of the Central New York Power Corporation.

These heaters have U-tubes to eliminate necessity for floating head construction as the U-bends take care of differential expansion.

Four heaters with Monel tubing were placed in service at this station during 1940-41.

They have not been idle a moment . . . nor cost a penny . . . for repairs!

Monel performs faultlessly because of its *unique combination of properties*. Monel retains strength and toughness at high temperatures. It resists the formation of corrosion film which would decrease the efficiency of heat transfer properties.

Monel tubing in these heaters, bought before the war, helps supply essential war power today . . . when current Monel production is devoted to direct military needs.

★

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York 5, N. Y.**

★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet...Strip...Rod...Tubing...Wire...Castings

No Shutdowns necessary for

SOOT or SCALE REMOVAL

XZIT

works while your boilers operate

No Time Lost...

Easy to Use...

XZIT, a scientifically formulated chemical compound, offers you a simple, sure method of counteracting the damage, the serious production set backs, that carbon deposits on boiler heating surfaces, uptakes, breechings and stacks provoke. XZIT not only makes it easier to remove soot and fire scale —it discourages their further formation. ALL while your boilers operate!

Harmless to metal and brick.

XZIT SALES CO.
1031 CLINTON STREET
HOBOKEN, NEW JERSEY

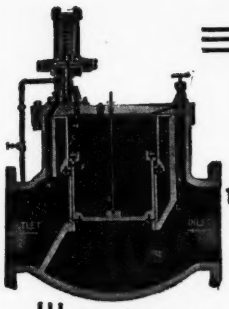
ment for employes at plant, with initial group of dwellings to cost about $1,000,000, and additional homes to be constructed at later date. Offices for project have been established at 111 West Lewis Street, Pasco, by duPont company. G. P. Church is project manager, and W. W. Campbell, chief engineer. Work on initial plant buildings is scheduled to begin at early date.

Other project will cover an alumina processing mill, for the extraction of such material from clays in Clackamas County, Ore., and Cowlitz County, Wash. Plant will be a development of Columbia Metals Corp., Portland, Ore., and will be designed, constructed and operated for that company by Chemical Construction Corp., 30 Rockefeller Plaza, New York, N. Y., a subsidiary of American Cyanamid Co., same address. Plant site is now being determined, to be situated in an area where power service can be secured from Bonneville transmission system. It will consist of a number of one and multi-story buildings, equipped to operate under a special process for extraction of alumina from clay on basis of about 50 tons of finished material per day. Several storage and distributing structures will be built, as well as administration building, laboratory, mechanical shops and miscellaneous structures. Power substation will be built for connection with Bonneville high-tension lines. Plant is estimated to cost about $4,000,000, with financing to be provided by RFC and its subsidiary, Defense Plant Corp., Washington, D. C. Mining plants for the production of clays in the districts noted will form part of project, with machinery and facilities to provide an estimated average supply of 250 tons per day for processing plant.

Tacoma Advances Work On Hydroelectric Project

Department of Public Utilities, Tacoma, Wash., has active construction in progress on additions to its municipal hydroelectric power plants and system, for which contracts were awarded several months ago. The development is located on the Nisqually River, about 34 miles south of city. It includes construction of two new power dams, known as Alder and La Grande dams, respectively; a generating station at the first mentioned dam; an addition to present power plant at La Grande dam; and construction of 6400 lin ft of concrete-lined tunnel, with finished inside diameter of 14½ ft, which will conduct water to the La Grande station, replacing a smaller existing tunnel.

This tunnel and the addition to the La Grande station are scheduled for completion by November 15, 1943. The new Alder dam and generating station will be finished on February 1, 1944. The two power dams and the Alder station will cost approximately $6,000,000; the concrete-lined tunnel and addition to La Grande power plant will cost about $2,000,000. A new 40,000-kw hydraulic turbine-generator unit will be installed in the last noted station, operating under a head of more than 400 ft. Two 25,000-kw hydraulic turbine units will be installed in the Alder generating station. The complete development, including transmission lines to city, power substations and other operating facilities, is estimated to cost close to $17,000,000.



SINGLE ACTING SEMI-THROTTLING ALTITUDE VALVE ★

Installed in upstream line to tanks, standpipes or reservoirs, this valve sensitively maintains any desired water level to prevent overflow.

The valve is semi-throttling by gradually closing as water approaches the maximum water level to be controlled. The valve is self-contained without any waste of water from above the valve piston, and is especially desirable for service where a low head is to be maintained against a higher influent pressure.

Write for Specifications

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

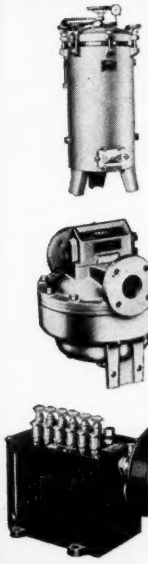
Turbine Driven IMO Pumps

Depending upon viscosity and other conditions, the De Laval-IMO Oil Pump can either be coupled directly to the shaft of a steam turbine or through a speed reducing gear, as here shown. This unit is designed for continuous service, the turbine having its own "lube" oil pump, oil cooler, filter, and rate-of-flow indicator, and being protected by a mechanical governor and a pressure release valve. The main pump has only 3 moving parts, and no valves, gears or cams. It is perfectly balanced, both hydraulically and rotationally and the discharge is free from pulsation.

Ask for Publication I-109.

IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton, New Jersey

To Win the war of Production -



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Production! MORE Production! That's today's challenge to industry! More metal parts for planes, tanks, guns . . . more liquids . . . longer machine hours . . . mean that more liquids must be handled. And, that is where Bowser can help you . . . because it has specialized in liquid handling systems for 57 years. To help you, Bowser makes filters for cutting oils, coolants, water, petroleum products and many other liquids . . . accurate meters for measuring many kinds of liquids . . . lubricators and lubricating systems to keep machines running . . . wheel tanks, automatic liquid blending systems, stills for recovering cleaning and other solvents, flow indicating devices . . . and many other items. Whenever you have a problem of liquid handling . . . consult Bowser first! Have a Bowser man call —or write for a copy of the Bowser Industrial Equipment Catalog.

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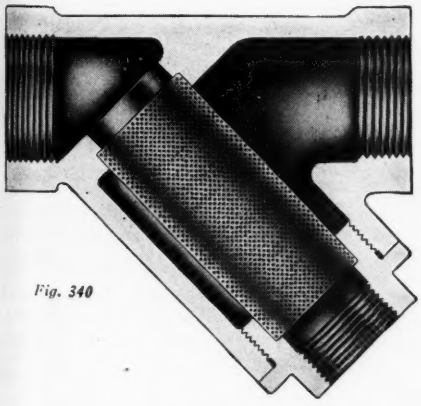

Fig. 340

War has curtailed our civilian manufacturing—and multiplied the difficulties of your job. But don't let it get you down. If you have a problem involving pressure or fluid control—an installation, operating or maintenance problem—we can save you days of work and worry. Call on our new VALVE PROBLEMS CLINIC. All the know-how of 65 years of specialization is yours for the asking . . . no charge, no obligation, no red tape. Whether or not you are using K & M equipment . . . we invite you to CALL ON K & M.

K & M PILOT OPERATED REGULATING AND REDUCING VALVE—*providing dependable close regulation for any difficult reduction service. The pilot action assures accuracy regardless of inlet pressure variation. Shuts off tight in dead end service. Built for initial pressures up to 600 lbs.—with reduced pressure ranges of from 2 lbs. to 80% of the inlet pressure. Sizes 2" to 12".*

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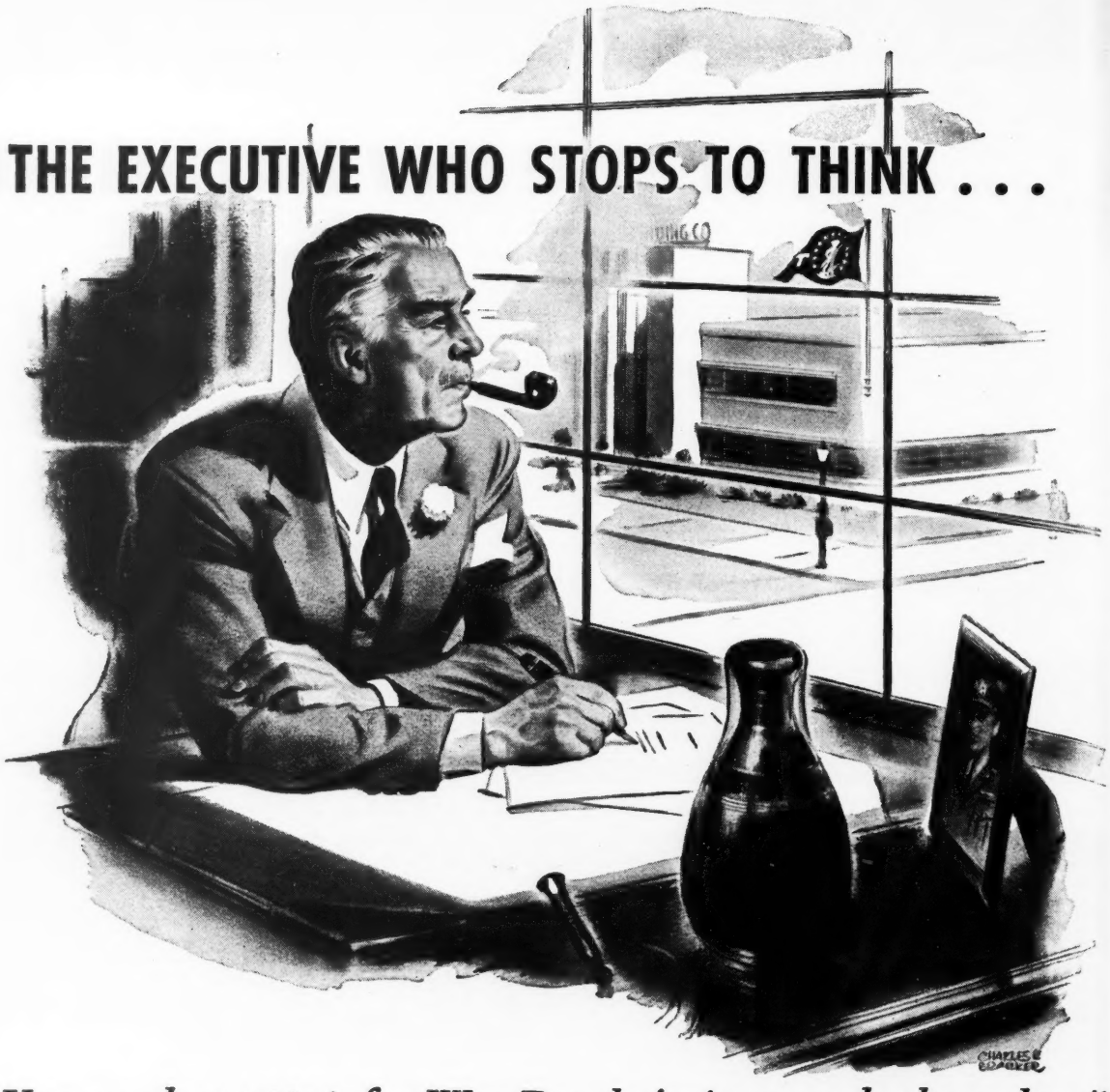
ENGINEERED PRESSURE & FLUID CONTROL SPECIALTIES

NORTH BERGEN, NEW JERSEY

Representatives in all Principal Cities

THE EXECUTIVE WHO STOPS TO THINK . . .



Knows that "10% for War Bonds isn't enough these days"

Workers' Living Costs going up . . . and Income and Victory Tax now deducted at source for thousands of workers . . .

Check! You're perfectly right . . . but all these burdens are more than balanced by *much higher* FAMILY INCOMES *for most of your workers!*

Millions of new workers have entered the picture. Millions of women who never worked before. Millions of others who never began to earn what they are getting today!

A 10% Pay-Roll Allotment for War Bonds from the wages of the family bread-winner is one thing—*a 10% Pay-Roll Allotment from each of several workers in the same family is quite another matter!* Why, in many such cases, it could well be jacked up to 30%—50% or even more of the family's *new* money!

That's why the Treasury Department now urges you to revise your War Bond *thinking*—and your War Bond *selling*—on the basis of *family* incomes. The current War Bond campaign is built around the family unit—and labor-management sales programs should be revised accordingly.

For details get in touch with your local War Savings Staff which will supply you with all necessary material for the proper presentation of the new plan.

Last year's bonds got us started—*this year's bonds are to win!* So let's all raise our sights, and get going. If we all pull together, we'll put it over with a bang!

This space is a contribution to America's all-out war effort by

POWER PLANT ENGINEERING

you've done your bit

. . . now do your best!

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

HELPFUL BULLETINS

Practical answers to many wartime problems of plant operation and maintenance are found in the engineering bulletins offered by manufacturers. For your convenience we publish the following summary of helpful literature available. To obtain copies of the bulletins and catalogs described, simply indicate the paragraph numbers on coupon on next page, detach and mail.

BOILER PLANT EQUIPMENT

1 Fully Automatic Stokers — New bulletin "The Why, What, and Who of Economical Heating" shows construction features of Winkler automatic stokers with capacities up to 750 lb of coal per hr. Also contains handy chart for figuring comparative costs firing with stokers, hand, oil and gas. U. S. Machine Corp.

2 Data on Steam Costs and Profits —Helpful new 48 pg booklet, "Dividends From Your Power Plant", outlines in simple layman's language the aspects of boiler efficiency. Discusses natural vs mechanical draft, CO, CO_2, excess and other factors affecting steam costs. Includes practical examples, sketches and tables. Preferred Utilities Co.

3 Conversion to Coal—New Link-Belt Conversion Book No. 1970, describes their commercial and industrial stokers in a full range of sizes up to 300 bhp available for conversion from oil or gas to coal. Link-Belt Co.

4 Boiler Tube Cleaner — Bulletin shows how use of Airetool tube cleaners quickly remove fuel wasting scale. New form cutter used in cleaner head will not damage hard-to-replace tubes. Sizes for straight or bent tubes, ½ to 20 in. Airetool Mfg. Co.

5 Coal Reference Bulletin — "Will There Be Enough Bituminous Coal in 1943?" is one of the questions answered in a recent reference bulletin issued by the Coal Bureau, Upper Monongahela Valley Assoc. Also supplies advice to new coal users, an important boiler plant case history and two pages of practical charts and data dealing with coal size selection and current price relationships.

6 Underfeed Stokers—Four-pg folder describes Frederick screw underfeed type stokers recommended for heating and pressure installations requiring from 20 hp to 150 hp. The Frederick Iron & Steel Co.

ELECTRICAL EQUIPMENT

7 Electrical Maintenance Equipment—Martindale communtator stones, slot cleaning outfits, insulating varnish, armature testers and many other electrical maintenance items are described in new Catalog No. 24. Contains 48 pg, many illustrations. The Martindale Electric Co.

8 Pivot Base Motors—Folder gives helpful operating and construction data on Burke pivot base motors. All types of Burke motors and generators for V or flat belt, or short center drives can be mounted on Burke pivoted bases which automatically keep belt tension in proportion to the load, prevent belt slippage and allow higher belt speeds. Burke Electric Co.

9 How To Test Insulation—Bulletin 1640 tells how to test insulation and avoid trouble in electrical equipment. Should be helpful in forestalling breakdowns of motors, generators, cables and other equipment. James G. Biddle Co.

10 Wartime Conservation—100-pg indexed handbook contains recommendations for effecting savings of critical materials in the application and use of Westinghouse motors, switchgear, transformers, meters and other equipment. Also tells you how to get more production out of present equipment. Westinghouse Electric & Manufacturing Co.

11 "Fuseology"—This handbook on fuses shows you how to reduce electrical outages and tells you how to get more service out of your fuses. Packed full of money-saving data that should enable you to save material and cut maintenance costs on motor installations. Bussmann Mfg. Co.

12 Single-Operator Arc Welders — Type WD, direct-current, single-operator arc welders are discussed in a new 12-pg bulletin (GEA-1440J) recently issued by the General Electric. Describes the operation of these engine- or motor-driven welders, and cutaway illustrations show important construction details. Other illustrations show both types of welders at work on various jobs. Bulletin also lists advantages of Type WD welders—the ease with which they can be started, their smooth, steady performance, broad current range, high rate of production, and low operating and maintenance costs. General Electric Co.

13 Electric Brake — New bulletin describes in detail the Magdraulic electric brake, which operates with only approximately 2 amperes. Engineering drawings giving the dimensions of three stock sizes, as well as the approximate torque which each of these brakes delivers, are included in this bulletin. Empire Electric Brake Co.

FANS, PUMPS AND COMPRESSORS

14 Glass Centrifugal Pump — Bulletin 313, with skillful cutaway diagrams, shows construction of Nash glass centrifugal pump. Gives the chemical and process engineer a splendid new tool. Fully transparent, the pump will handle hot acids or brine cooled liquids. Capacity 600 gph. Not affected by temperatures up to 150 deg F in standard design. Nash Engineering Co.

15 Sanitary Pumps—Bulletin 115 pictures and describes Blackmer sanitary pumps as used in food and processing plants. Includes typcial capacity curve and specification table. Blackmer Pump Co.

16 Axial and Mixed Flow Pumps—A new 20 pg Booklet 7073 on vertical axial and mixed-flow pumps describes units for handling large volumes of liquid at comparatively low heads. These pumps are available in a complete range of sizes for capacities to 75,000 gpm and for heads to 100 ft per stage; are particularly well suited for such services as condenser circulating, mine and general sump drainage, dry-dock dewatering, process work, refinery processes, etc. Large cross-sectional views showing many features of design and construction. Ingersoll-Rand Co.

INSTRUMENTS AND CONTROLS

17 Pressure and Fluid Control Specialties—Catalog 66 contains complete data on a line of strainers, liquid level controls, pressure regulating and relief valves, steam traps, float valves, pump governors and power plant equipment. Company maintains a "Valve Problems Clinic", a clearing house of free information established to keep your machinery going. Kieley & Mueller. Inc.

18 Gages For Measuring All Kinds of Liquids—Bulletin 1037 describes a complete line of liquid level gages for measuring liquids of all kinds whether light or heavy. Dial readings can be provided in feet, inches, gallons, pounds, liters or by any other desired increment. By using these gages, accurate inventory of liquids is constantly available. The Liquidometer Corp.

19 Shunt Meters for Steam, Air or Gas—Bulletin 311 describes a line of mechanical shunt meters which provide a simple, direct and reliable means of tallying the dollars that flow through steam, air, and gas lines. Owing to their simple design and rugged construction, these meters require little attention while in service. Builders-Providence, Inc.

List Items You Want On Handy Coupon On Following Page

20 **Safety Water Gage**—Bulletin 434 illustrates and provides complete data on the Reliance PRISMATIC "Safety Water Gage" for both vertical and inclined installation. Sent free on request. The Reliance Gauge Column Co.

21 **Electronic Adjustable Speed Drive**—Mot-O-Trol, an electronic adjustable-speed drive which provides wide stepless range, automatic speed regulation and smooth fast acceleration with automatic current limitation is described in a new Westinghouse Booklet B3256. Charts show motor speed characteristics for a 20 to 1 speed range, 10 to 1 speed range, and constant speed. In the new drive, incoming a-c power is converted to direct current by thyratron tubes, which supply the direct current to armature and field circuits of the d-c driving motor. A potentiometer in the control station varies the voltage of the current by shifting the phase of the grid control voltage of the thyratrons. Both armature and field circuits are controlled by one dial on the control station. Westinghouse Electric and Manufacturing Co.

22 **Leaflet On Electric Gages**—"21 Electric Gages to Aid Production" is the subject of a new 8-pg article reprint (GEA-3991) which describes the functions of the gages, and contains a chart showing schematic representations of electric gage circuit applications. Included are thickness, magnetic, electrolimit, pressure, strain, and eccentricity gages. General Electric Co.

23 **Cooling Controls** — Twelve pg bulletin No. 700 on Sarco cooling controls, covers self-operated temperature regulators and mixing valves, to control cooling circuits on internal combustion engines, compressors, condensers, degreasers, stills, etc. Completely illustrated, including many typical hook-ups, also capacity tables, prices, etc. Sarco Co., Inc.

MECHANICAL TRANSMISSION

24 **V-Belt Care** — Free handbook "Plain Facts on Wartime Care of Rubber V-Belts" contains practical data showing how to prolong working life of all makes. Allis-Chalmers Mfg. Co.

25 **Worm Gears and Speed Reducers**—Besides giving a complete treatise on worm gearing in general, including dimensional sheets and hp tables, Catalog No. 200 includes some of the theory underlying worm gearing and gives a description of the processes used by this company in producing these units. The Cleveland Worm & Gear Co.

26 **Power Drives for Machine Tools**—"Up to 30 hp" is the theme of a 4-pg catalog, describing the three models of Western Transmissions for motorizing various cone driven machine tools. It illustrates how the multi-motor-mount makes practical the adaption of the three transmission models to most any cone driven machine tool . . . Fourteen different installations are pictured including lathes, shapers, milling machines, automatic slotters, vertical and horizontal boring mills, etc. Western Manufacturing Co.

27 **Leather Belting Handbook**—A 20 pg booklet "Leather Belting Conservation and Other Engineering Data" is now off the press. Contents include the proper selection, correct installation and maintenance of leather belts, methods for aligning shafting and pulleys, cleaning and dressing leather belts, horsepower ratings for oak-tanned flat leather belting, belt speed and recommended pulley diameter tables, belting formulae and specifications. Baldwin Belting and Leather Co.

PIPING VALVES AND FITTINGS

28 **Butterfly Valves** — New 4-pg illustrated Bulletin No. 16-B contains complete dimension tables for butterfly valves, 15 to 125 psi. Features valves for regulation and shut-off duty for air, gas, steam, liquids and semi-solids—manual and automatic control. Issued by R-S Products Corp.

29 **Radial Fin Liquid Filter** — New folder shows construction features and specification data on Staynew radial fin sump type liquid filter. Mounted on the end of pump suction lines this unit is said to protect the pump against sludge, cuttings, sand, etc. Easy to install and clean. Staynew Filter Corp.

30 **Traps for Every Purpose**—Bulletin 242 describes the Nicholson line of thermostatic traps, available in five sizes ¼ in. to 2 in., pressures up to 300 lbs. Catalog 941 gives complete data on high pressure traps—weight operated for pressures to 1500 lbs—piston operated for pressures to 650 lbs. W. H. Nicholson & Co.

31 **Handbook of Valve Data** — New Darling catalog, with more than 300 pg and 500 photos, contains latest valve data and specifications. Tells why certain mechanical features make valves work easier, give positive shutoff, cost less to maintain. Darling Valve & Manufacturing Co.

32 **Blow-Off Valves**—Catalog B-420 describes a line of blow-off valves with no seat to score, wear or clog with mud, scale and dirt. For pressures up to 400 lbs; catalog B-430, for higher pressures. Yarnall-Waring Co.

33 **Tilting-Disc Check Valves**—12 pg book gives engineering data and test results on Chapman tilting disc check valve. Exclusive Chapman design is said to cut head loss 65% to 80%. Airfoil design of disc offers minimum flow resistance—streamlined body contains no obstructions. Chapman Valve Mfg. Co.

34 **Data Book on Welding Fittings**—As much a text book as a catalog, 216-page presentation gives a wealth of information on welding fittings and forged steel flanges. Contains engineering data that will prove invaluable to the man who purchases, designs or specifies piping fittings and flanges in carbon and alloy steels. Taylor Forge & Pipe Works.

35 **Flexible Metallic Tubing** — New Catalog No. 113 describes the types of Titeflex flexible tubing used in the conveyance of oils, gases, and liquids. Complete data is given on available fittings, both industrial and S.A.E. Also included are complete pressure charts, charts showing radius of bend, and much other essential data. Many applications for flexible metal tubing are pictured and described. Titeflex Metal Hose Co.

WATER TREATMENT

36 **Chlorination of Condenser Cooling Water**—That is the title of Technical Reprint No. 468 which deals with the control of slime on the tube surfaces of condensers and other low temperature heat exchangers. Photos and diagrams are used to show practical applications. Wallace & Tiernan Products, Inc.

37 **Chemical Feeders**—Bulletin describes Manzel chemical feeders for automatic boiler feed water treatment. Installed on boiler pumps, they automatically feed a small amount of chemical into the line with each pump stroke. Easily adjustable to fit your exact requirements. Manzel Brothers Co.

38 **Zeolite Softener** — Elgin double check zeolite water softener equipment is illustrated and described in a new 4-pg folder No. 605. The design is said to increase softening efficiency and increase capacity, making it possible to use more Zeolite in a given softener without loss. Elgin Softener Corp.

39 **Water Conditioning and Chemistry**—"Boiler Feed Water Conditioning and Chemistry" is a new Cochrane publication which deals with the most common processes used in feed water conditioning, and a discussion of such important factors as the characteristics of the hot process water softener, zeolite softener, removal of gases from boiler feed water, embrittlement and carry-over also has a section devoted to interpretation of water anal-

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yses, conversion factors, chemical reactions, tables showing the formula, molecular weights, equivalent weights of all the chemicals commonly found in water conditioning practice. Cochrane Corp.

40 Reprint on Water Treating — "Water Treating" is the title of a recent Oil and Gas Journal article which is written in easily understood language and has information that will assist a new man in his water treating problems. The different kinds of corrosion and scale encountered in boilers and cooling systems are discussed, as well as the explanation of the external and internal water treatments used. Reprints now available without charge. D. W. Haering & Co., Inc.

MISCELLANEOUS

41 Packing Guide—Catalog 40 is a valuable packing guide of information on packings for all services. Clearly illustrates and describes various packings of this company; suggests varied packing styles from which to choose a substitute packing. Also provides engineering data and other informative charts. The Belmont Packing & Rubber Co.

42 Revolving Unit Heaters—Bulletin HR-2 furnishes complete design, construction, engineering data and installation planning on the Wing line of revolving unit heaters. Send for your free copy. L. J. Wing Mfg. Co.

43 Free Repair Handbook—A 40-pg guide for the use of Smooth-On cements contains 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

44 Floors Repaired While Traffic Rolls—Folder "Floor Patch" describes a product that repairs floors easily and allows you to open the spot to regular traffic immediately. Floor patch is solid and permanent. This new plastic bonds tight to old concrete and withstands extreme loads. Flexrock Co.

45 Pipe Line Filter — Bulletin 1033 pictures and describes Alco filters and pre-fabricated piping for oil pipe lines; also heat transfer units for power and chemical plants. American Locomotive Co.

46 Silent Check Valves—Catalog No. 140 covers construction and advantages of Williams-Hager silent check valves for pump lines. Also illustrates pump valves, pump governors, traps, water columns and other specialties. The Williams Gauge Co.

47 Plastic Coating Resists Corrosion —A plastic material which is applied like paint to protect boiler drums, metal, wood or concrete storage tanks and water-submerged surfaces against corrosion and fungus growths, is described in a new Serviron bulletin. Serviron stretches and contracts with temperature changes; it will not melt, freeze, crack or peel at temperatures from below freezing to 500-550 deg F. Serviron is used wherever clean, rust-free water is required, such as in drinking-water tanks, power plants, ships, schools, hospitals, laundries and process industries; may be used to coat valves, ammonia lines and underground pipes and tanks. Saverite Engineering Co.

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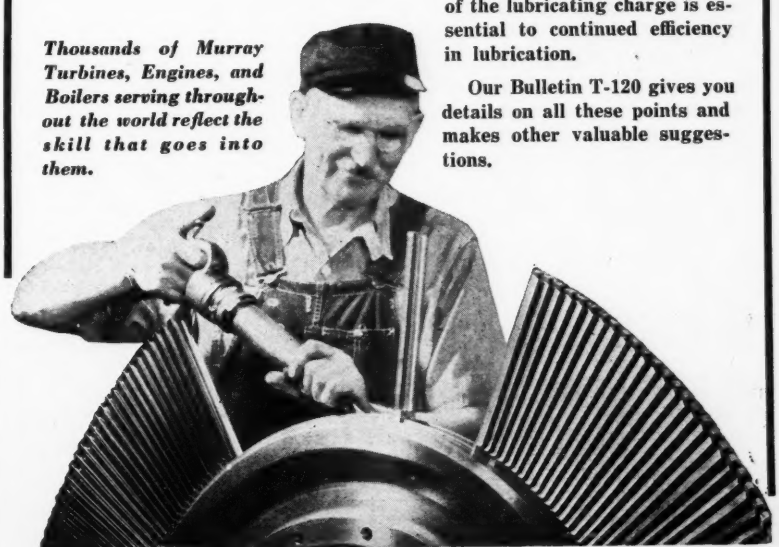
● CLEANLINESS: It is essential to guard against impurities gaining entrance and contaminating the oil. OIL TEMPERATURE: As oil temperature rises the tendency of the oil to oxidize and deteriorate is accelerated — we suggest that a careful check be kept on your oil temperature. OIL PRESSURE: The oil pressure provides an index to the proper operation of the system as a whole—all pressure changes, sudden or gradual, should be investigated. OIL LEVEL: To neglect the oil level in bearings or supply tanks is to jeopardize all other good work done toward maintaining correct lubrication. FOAMING: Breakdown of generator insulation, short circuits, etc. result through escaping oil due to foaming. On some installations it has been found that a slight reduction in the pressure at which oil is circulated will be beneficial—on others the correction has been accomplished by reducing the flow of water through the cooler and circulating the oil at a slightly higher temperature. Lack of oil is a likely cause of foaming. Adding too much new oil to the system at one time is another cause. SLUDGE: Possibility of this formation is minimized by using a high grade oil and keeping system free from impurities. DRAINING: Regular draining and renewal of the lubricating charge is essential to continued efficiency in lubrication.

Thousands of Murray Turbines, Engines, and Boilers serving throughout the world reflect the skill that goes into them.

Our Bulletin T-120 gives you details on all these points and makes other valuable suggestions.



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"BUCKET DESIGN"—SELF-ADJUSTING FOR WEAR

Skilled Men Needed for Merchant Fleet

BY THE END of 1943, according to estimates of the War Shipping Administration, the United States will have 2300 new ships sailing the seas carrying materials to the fighting fronts. These ships will require 120,000 men to keep them in operation.

Among the types of skilled workmen needed are qualified engineers. It is stated by Marshall E. Dimock, assistant deputy administrator of recruitment and manning, that working conditions and wages in the Merchant Marine have steadily improved since 1935. Standing at an all-time high, they now compare favorably with the conditions in industries of the country. In addition to a basic wage, voyage bonuses of 40 to 100 per cent are paid, as well as port bonuses, overtime, and war-risk insurance.

Full recognition by the Government has been accorded to the part played in this war by the men of the Merchant Marine, as they are considered as much a part of the nation's battle line troops as their comrades in arms of the Army, Navy and Marines.

The Recruitment and Manning Organization of the War Shipping Administration, Washington, D. C., or any of its local offices are in position to discuss qualifications of engineers desiring service in the Merchant Marine.

Report on Electric Rates

THE FEDERAL POWER COMMISSION recently announced the publication of a report showing, in the form of typical net monthly bills, electric rates as of January 1, 1943, for residential, commercial light, commercial power, and industrial services in the 200 cities throughout the United States having populations of 50,000 and more according to the 1940 census. These cities are served by 153 utilities.

Rate reductions in one or more typical bills for residential service were made in 17 of the 200 cities during 1942, as compared with reductions made in 37 cities during 1941. Increases in one or more typical bills for residential service were made in 3 cities in 1942. In two cases the increases were for certain block of consumption only and were accompanied by decreases in bills for other blocks. In 182 of the cities no changes occurred.

Lowest and highest typical bills reported show differences in charge for identical quantities of electric energy of from 153.8 per cent to 257.6 per cent, the highest percentage of difference being between the bill of $1.70 rendered users of 100 kilowatt-hours by Tacoma's municipal plant and the $6.08 bill rendered users of the same amount of energy in St. Petersburg, Florida, by the Florida Power Corporation. The 1943 report shows that changes in the lowest and highest typical bills among the major cities since January 1, 1942, resulted in a drop from 171.8 per cent to 169.1 per cent difference between the lowest and highest bills rendered for 40 kilowatt-hours and from 221.3 per cent to 183.8 per cent for 500 kilowatt-hours. Other percentage differences showed no change.

Farm Electrification to Expand

OFFICE OF WAR UTILITIES, WPB, Washington, D. C., has issued notice that farm electrification line extensions in excess of 5000 ft. will now be permitted, the removal of former restrictions being intended to increase food production. Such extensions have been denied in the past owing to scarcity of materials required. The same general regulations apply to longer extensions as have been applicable to shorter line construction projects, which have been securing approval since January 1, 1943, these being a certain number of animals on the farm, plus a showing that electricity will go to increase food production, and that electrical equipment is available or procurable.

Bearings

PRODUCTION of bearings used in all types of machines where friction is developed can be increased 25 per cent without extending manufacturing facilities, members of the Bearing and Bushing Industry Advisory Committee told War Production Board officials at a recent meeting.

The members pointed out that the increase could only be assured contingent upon steel requirements of the industry being met by steel mills with satisfactory delivery schedules both as to tonnage and sizes.

The importance of the bearing and bushing production program in the war effort, officials of the Steel Division said, was recognized by the War Production Board, and every effort is being made to insure manufacturers of these products enough properly-sized steel to permit the maximum scheduled production.

LET THIS LOW COST METER *Tell You*

WHAT TO CHARGE TENANTS FOR STEAM

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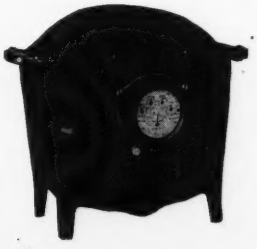
HOW TO ALLOCATE STEAM COSTS TO DEPARTMENTS AND PROCESSES

ADSCO Rotary Condensation Meters will give you these answers—will tell you when the peak loads occur—will enable you to detect and stop steam losses.

These low cost meters are easy to read. Simply subtract present reading from last reading, same as gas or rate meter. Quickly installed—easily maintained. Factory tested for accuracy within 1%. Standard in industrial plants, colleges, institutions and district heating companies.

Put your steam on an accounting basis. Write for quotations, advising us the maximum pounds of condensation per hour or the equivalent direct radiation in the building or department. Also ask for bulletin 35-80E.



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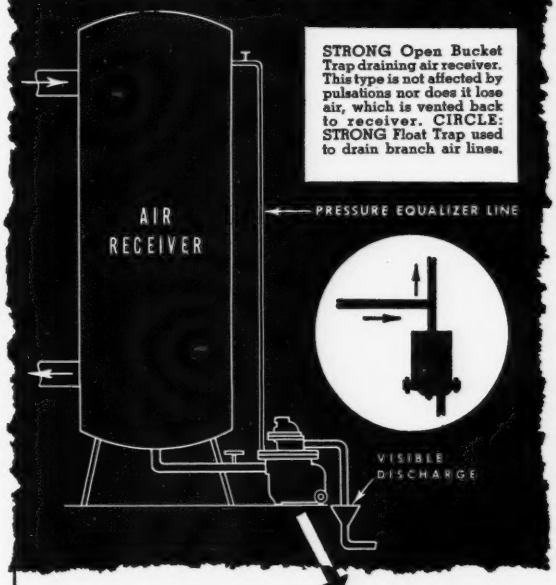
MAKING "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 60 YEARS

Reads Directly in Pounds of Steam Used
ADSCO ROTARY CONDENSATION METER

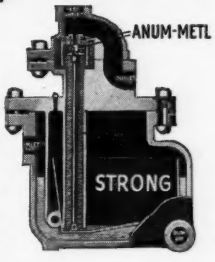
DRAIN RECEIVERS WITH NO AIR LOSS



STRONG Open Bucket Trap draining air receiver. This type is not affected by pulsations nor does it lose air, which is vented back to receiver. CIRCLE: STRONG Float Trap used to drain branch air lines.

Reciprocating compressors cause pressure surges in air receivers. These pulsations tend to "bounce" buckets of inverted bucket traps, resulting in excessive wear of parts, continual discharge and loss of air.

STRONG Open Bucket Traps are not affected by such pulsations. Only the weight of condensate in the bucket causes them to discharge. No air is lost during discharge, and air displaced from the trap by incoming condensate is vented back to the receiver.

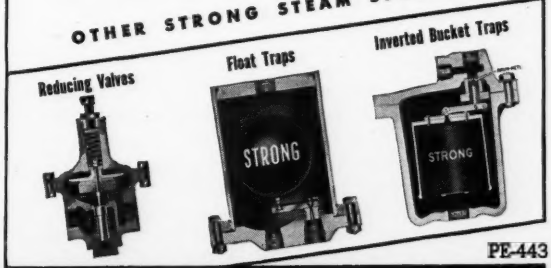


This hook-up also is used for draining gas receivers and accumulators. Where liquids other than water are handled, special traps are furnished.

• • •

Completeness of the STRONG lines enable us to recommend exactly the type and size you need—open or inverted bucket, closed float, float-and-thermostatic (blast), etc.—forged, fabricated (welded), cast and semi-steel construction. Send your problems to Strong, Carlisle & Hammond Company, Cleveland, Ohio.

OTHER STRONG STEAM SPECIALTIES



PE-443

STRONG
STEAM SPECIALTIES

NEW ENGINEERING BOOKS

Dynamical Analogies. By Harry F. Olson. First edition, 196 pages, 5¾ by 8½ in., cloth, illustrated. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y., 1943. Price $2.75.

It is always easier to understand a new principle or device if it can be explained in terms of something we already know. A good teacher makes use of this principle in teaching; he uses analogies. By means of analogies an unfamiliar system may be compared with one that is better known. A simple example is the analogy between a pendulum and a tuned electric circuit. It is difficult for a beginner to know what goes on in an oscillating circuit but he does understand the action of a pendulum; hence if the electric circuit can be explained in terms of the pendulum the process of learning is made easier. For this reason as well as many others, this book on dynamical analogies is a welcome addition to technical literature. It covers a wide field and the subject matter is developed in stages from the simple elements through to complex arrangements of multielement systems. It presents the fundamentals of rectilinear and rotational vibrations in acoustical systems under both steady-state and transient forces and pressures. Among its many basic subjects are systems of different degrees of freedom, corrective networks, isolators, filters, transients, theorems and applications in electrical, mechanical and acoustical systems and electromechanical transducers. The fundamental information has direct value in the control of linear and rotational vibrations in motors, generators, transformers, engine frameworks, gear trains, etc.

The explanations are especially clear and detailed, and they are accompanied by remarkable composite illustrations which bring all related systems together at once. The book should be of great help in the solution of problems in the suppression of noise, the control of impulsive forces, and the design of constant speed mechanisms.

It is interesting to know that the author is Acoustical Research Director of the RCA Laboratories at Princeton, N. J., because in few branches of engineering have analogies been used more effectively than in the communication field. This is a book for all engineers, electrical, mechanical, structural, chemical—all should find it useful. The text assumes on the part of the reader a familiarity with the elements of alternating current circuit theory and physics.—A. W. K.

Electromagnetic Waves. By Sergei A. Schelkunoff. First edition, 500 pages, 6¼ by 9¼ in., cloth. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. 1943. Price $7.50.

This book presents the theory of electromagnetic waves, for practical purposes and for practical ends. It gives the engineer answers to fundamental questions regarding radiation, wave propagation in ordinary transmission lines and in high frequency wave guides, cavity resonators, electric horns and many other topics. For those engaged in mathematical research it provides numerous equations which can serve as points of departure in solving new problems. Mathematics is used freely but it is developed in a simple and straightforward way that should be comprehensible to anyone familiar with college mathematics. This book is, in short, a broad account of electromagnetic waves that is both analytical and thorough, yet is understandable to a majority of engineers.

The text is characterized by a unity of method and purpose which well adapts it for study by engineering and physics students, or for direct application in engineering work. It stresses the unity of all transmission problems, and it regards the circuit theory, the transmission line theory, and the field theory as natural subdivisions of one theory. The field theory is treated merely as a three-dimensional transmission theory. Consistent emphasis is placed upon the physical meanings rather than upon mathematical processes to make it more understandable to those studying, applying or investigating electromagnetic waves.

The author, who is a member of the technical staff of Bell Telephone Laboratories, Inc., is well qualified to write this book. As he points out in the preface, on the whole, the book is an outgrowth of his research and consulting activities in the Bell Laboratories. Its first draft was prepared in connection with courses and lectures in the Laboratories' educational program.

This photo was taken at the invitation of the Muzak Transcriptions, Inc., at their new New York plant for the manufacture of fine radio transcriptions of programs for broadcasting. Sarco selected float-thermostatic steam traps for the platens on the molding presses to secure continuous condensate removal without disturbing the temperature control; inverted bucket steam traps for the dryer coils and steam lines because they can stand hard knocks; Sarco thermotons for the cleaning and plating tanks because they combine temperature control at the cost of steam traps alone. Simple Sarco type LSS electric thermostats provide temperature control for the ovens.

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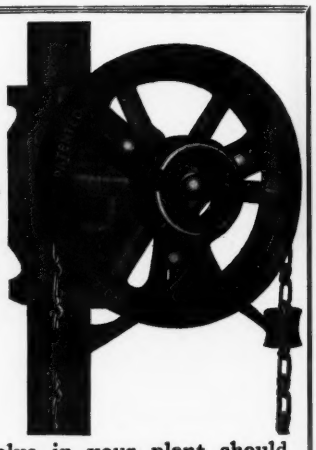
For All "HIGH-UP" VALVES



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Babbitt
—Adjustable—
SPROCKET RIM
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For Sharper Water Gage VISIBILITY

It will pay you to send for this new Bulletin No. 434

on Reliance PRISMATIC INSERTS

The Reliance Gauge Column Company 5902 Carnegie Avenue Cleveland, Ohio

ALBANY GREASE cools HOT BEARINGS quickly

... the tallow does it

When the lack of lubricant in a bearing causes friction and the temperature rises, Albany Grease melts and feeds enough to maintain perfect lubrication. And because of its tallow base, Albany works *fast*.

Moreover, the firm ring which Albany Grease maintains at the end of a bearing prevents the entrance of abrasive particles and resultant wear.

Albany Grease is available in three densities — adapted for use with grease cups or open bearings operating at temperatures up to 200 deg. F.

Write for your free copy of helpful Lubrication Chart.

1868 1943 75th Anniversary Albany

ADAM COOK'S SONS, INC.
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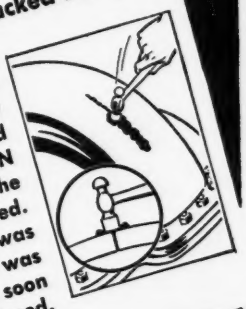
SMOOTH-ON REPAIR RECORDS

Repair of Cracked Pump



The surface of the crack in this pump casing was cleaned and the edges of the crack slightly beveled by a sharp-pointed tool. A putty of SMOOTH-ON No. 1 was then forced into the crack until the crack was filled. No heat or dismantling was required, and the pump was again ready for use as soon as the SMOOTH-ON hardened.

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FREE Repair Handbook Shows How

40 Pages, 170 Diagrams, simple practical instructions for ingenious repairs to plant equipment, pipe lines, structures. Based on experiences of engineers all over the country. To obtain your FREE copy, just fill in mail the coupon.

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Courses were given in 1933-34 and 1934-35 and in 1941-42. In the summer of 1942 the author gave a course on Electromagnetic Waves at Brown University in connection with its program of advanced instruction and research in mechanics which enabled him to test the book in manuscript.

On the whole, it is one of the most comprehensive books on the subject that one could ask for. It is well indexed and includes, at the end of the book, a group of problems and exercises.—A. W. K.

The Electric Light and Power Industry in the United States—Year 1942. Statistical Bulletin No. 10, Publication No. K-2. Size 8¼ by 11 in.; 40 pp; paper bound. Published by Edison Electric Institute, 420 Lexington Ave., New York City. Price 75 ct.

Published in May 1943, this is the latest in the well-known series of statistical bulletins of the EEI giving complete data on the industry providing electricity for the public supply. These data are compiled with the cooperation of the Federal Power Commission and, as is well known, constitute the authoritative statistics on the subject at any given time. Electricity is supplied for public supply by the electric utility companies, municipal electric utilities, Governmental power districts, certain mining and manufacturing plants, electrified railways and railroads and certain non-central stations.

Part I consists of tables and graphs presenting the operating statistics of the industry, including generating capacity, generation of plants and generation by states and by months, also fuel consumption data. It includes tables of energy for distribution, of sales and revenue and farm service.

Part II gives miscellaneous statistics on domestic appliance sales, construction expenditures and circuit miles of line. Part III gives financial statistics of the electric utility companies.

Part I begins with a summary of the electric light and power industry's operation in 1942, showing how the supply has proved equal to the war demand. This is accompanied by an interesting graph showing load curves from 1938 to 1942. In this graph is shown some of the outstanding characteristics of the 1942 operations; namely, that by balancing of load, industrial conversion, interconnections, the dimout, daylight saving and other factors, the evening peak load for a typical December day, 1942, did not rise much higher than the evening peak load of a day in 1941, whereas the 9-10 a. m. morning peak in 1942 was somewhat higher than the evening peak. This curve differs from that of previous years, in which the morning peak was always much lower than the evening peak. The effect of this, of course, has been to increase the total output of kilowatt hours by 11.7 per cent over that of 1941 with only a comparatively small increase in total generating capacity and a material improvement in load factor. In short, accompanying the greatest industrial war effort ever put forth by any country, there has been no shortage of electric power to meet all the demands placed upon the industry, as has been repeatedly pointed out in these columns and elsewhere.—C. R. E.

Fundamentals of Electricity. By Wynne L. McDougal, Richard R. Ranson, and Carl H. Dunlap. Size 5½ by 8½ in.; 388 pp; cloth bound.

Fundamentals of Machines. By Glenn M. Hobbs, L. H. Morrison and Ray F. Kuns. Size 5½ by 8½ in.; 294 pp; cloth bound.

Fundamental Shop Training. By John T. Shuman, Captain Bailey Wright and James Ritchey. Size 5½ by 8½ in.; 327 pp; cloth bound.

All published by American Technical Society, Drexel Ave. at 58th St, Chicago, Ill. Price $2.00 each.

These three textbooks have been published by the American Technical Society at the request of the U. S. Office of Education and the War Department for use by those who are preparing for war service. Each volume is accompanied by a workbook. The textbooks have been prepared so that each presents the prerequisite knowledge in its field in the simplest manner and the workbooks contain laboratory and project problems and a complete classroom study program.

One of the most interesting features of these three books is the large number of very clear and simple illustrations of methods and equipment. Wherever possible, these use familiar objects such as an ordinary force pump, a roller coaster and so on, to explain elementary principles and photographs and drawings of the actual motors, electrical instruments, airplane parts and tools that the student will actually encounter later in his training.

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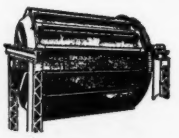

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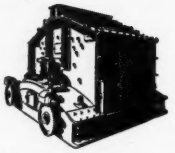

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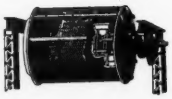

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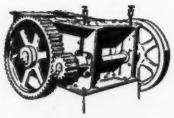

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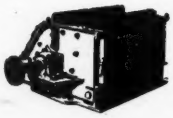

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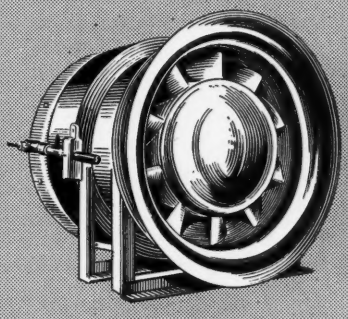

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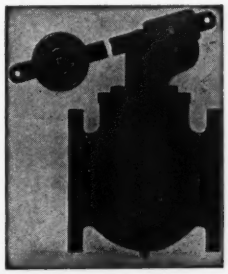

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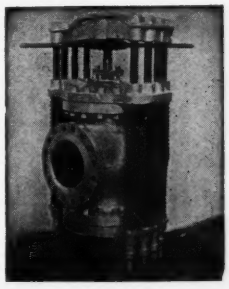
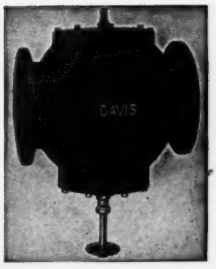


Left — No. 265 Turbine Bleeder and High Pressure Relief Valve.



Right — No. 110 Exhaust Relief Valve for condenser protection service.

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lowing the War Department's recommended outline, for automobile, airplane and engine mechanics; telephone and telegraph linemen and operators; ammunition handlers; construction foremen; radio operators, mechanics and repairmen; fire control instrument operators; motorcyclists; antitank gunners; and electricians.

After a brief discussion of the fundamental theory of electricity and magnetism, based on the electron theory, the book discusses elementary circuits, primary and storage batteries, resistance, series and parallel circuits, electrical measurements and the meters used, principles of motors and generators. It includes electrical symbols and a dictionary of electrical terms and formulas.

Fundamentals of Machines and its workbook comprise a basic course in the fundamentals of machines, for tank engine mechanic, driver or commander; driver of scout car, reconnaisance car, ambulance, wrecker, or motorcycle; portable power operator or repairman; power turret maintenance man; bridge foreman; truck master; demolition specialist; mine planter; search-light operator; artillery mechanic; aerial engineer, or noncommissioned officer in motor transportation.

General principles of practical physics are discussed in the first half of the book and in the last half their application is shown to blocks and tackle, automobile design and construction, automobile engines, and aircraft and Diesel engines. A chapter on automobile engine troubles is also included.

Fundamental Shop Training and its workbook is for automobile, airplane, engine, radio and artillery mechanics; radio, telephone, telegraph repairmen, operators and mechanics; shop or construction carpenter, or construction foreman; welder; electrician; bridge builder, or airplane armorer and the like.

The book first describes and illustrates clearly all the common hand tools, then explains very simply and clearly the elementary processes of chipping, filing, scraping, hand threading and linear measurement. Operation of drilling machines and the engine lathe are discussed and there is a good chapter on details of airplane construction and another on cable splicing. The book ends with chapters on electrical wiring and splicing, woodworking, painting and wood preservation and rope splices and knots.—J. G.

Industrial Fire Brigades Training Manual. Prepared by the N.F.P.A. Committee on Firemen's Training, a group of leading fire chiefs and fire protection experts. 184 pages. 8½ by 11 in. Single copies $1.50 postpaid from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

This volume, recently published by the National Fire Protection Association, is designed to meet three widespread demands: First, as a training manual for employees assigned to carry out fire fighting duties under direction of the chief of the private brigade; second, as a reference book in those plants where a fire brigade is already organized, but where the experience of a large group of experts can be profitably utilized; and third, in those plants which need the essentials but not the details of large plant fire protection organization.

The book is divided into 16 chapters as follows: The Industrial Fire Brigade; Forcible Entry Practices; Rope Work; Fire Extinguisher Practices; Ladder Practices; Hose Practices; Salvage and Overhaul Practices; Fire Streams; Ventilation Practices; Periodic Inspections of Plant Fire Protection Equipment; Care of Fire Brigade Equipment; Fire Causes and Fire Hazards; Fire Fighting Procedure; Flammable Liquid and Gas Fires and Special Extinguishing Systems; Electrical Fires; Gas Masks and Rescue Practices.

The private brigade is probably the most important part of the fire safety organization. What to do when a fire occurs is what each member of the brigade must know before a fire occurs. The department heads must know that employees are organized to know how to prevent fires, how to use fire extinguishers, hand hose, and other first aid fire appliances. But it is up to the manager of the plant to arrange for the organization of a plant fire brigade.

Save Fuel for Victory. Size 6 by 9 in., 35 p.; paper bound. Published as Circular Series No. 47 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 35 ct.

This booklet contains a series of non-technical articles about insulation, heating-plant efficiency, and related subjects, originally presented as talks over the University of Illinois Radio Station WILL by members of the staff of the Department of Mechanical Engineering in the College of Engineering, and the Engineering Experiment Station of the University.

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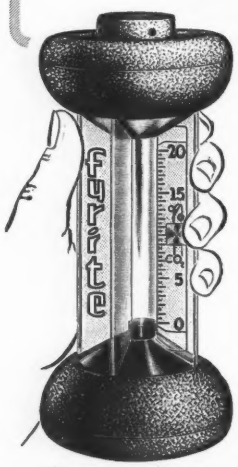

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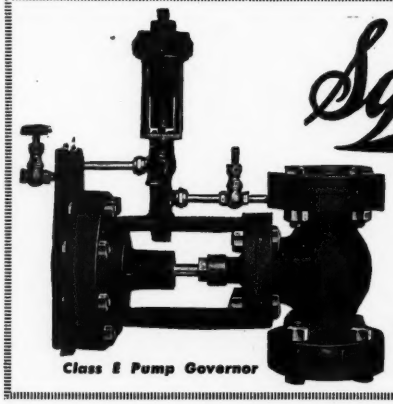

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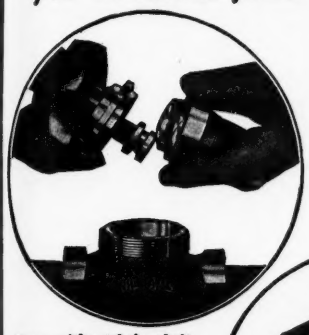

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Power Plant Construction News

Calif, Selma — Selma Dehydrating Co., Selma, recently organized subsidiary of Kingsburg Cotton Oil Co., Kingsburg, Calif., has acquired a local industrial plant and will modernize and expand for new fruit dehydrating plant. Electric power equipment will be installed. Cost estimated close to $185,000, with machinery. E. J. Cecil is president of parent company.

Fla., Jacksonville—Municipal Electric Department, Utilities Building, will begin work soon on extensions and improvements in steam department in municipal power plant, including installation of a new boiler and auxiliary equipment. Burns & Roe, 233 Broadway, New York, N. Y., are consulting engineers.

Ga., Columbus — Bibb Mfg. Co., Macon, Ga., manufacturer of cotton goods, plans installation of electric power equipment in connection with expansion and conversion of branch mill at Columbus for manufacture of rayon tire cords for synthetic rubber automobile tires. Cost estimated about $1,250,000. Project has a priority rating and will be placed under way soon.

Ind., Kendallville—Board of Public Works, Kendallville, has plans maturing for extensions and improvements in municipal power station, including installation of a new boiler, stoker and auxiliary equipment. Cost estimated close to $100,000. R. W. Noland, Medical Arts Building, Fort Wayne, Ind., is consulting engineer.

Kan., Kansas City—Department of Streets and Parks, Francis W. Blake, commissioner, is completing plans for extensions and improvements in three municipal pumping stations used for water system, in Argentine, Shawnee and Armourdale districts, respectively. Additional equipment will be installed. Cost estimated about $125,000. Benjamin Orvis is acting city engineer.

Ky., Louisville — National Carbide Corp., 715 South 26th St., manufacturer of industrial chemicals, calcium carbide, etc., will carry out expansion in plant for production for Government, including additional building and installation of machinery and electric power equipment for considerable increased capacity. Cost estimated about $700,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency.

La., Morgan City—City Council has tentative plans under advisement for extensions and improvements in municipal power plant and system, with installation of equipment for increased capacity. Also proposes extensions in municipal waterworks station and system. Entire project is reported to cost about $125,000. It is planned to apply for a priority rating for project.

Mass., South Lancaster—Board of Trustees, Atlantic Union College, has approved plans for new multi-story power plant, about 55x145 ft, for central power and heating service at institution. Cost estimated close to $100,000, with equipment. Construction is scheduled to begin at once. Albert J. Roy, 22 Elm St., Worcester, Mass., is architect.

Mich., Marysville—Dow Magnesium Corp., Midland, Mich., an interest of Dow Chemical Co., same address, plans installation of electric power equipment in connection with proposed rebuilding of portion of magnesium plant at Marysville, recently destroyed by fire, with loss reported over $300,000, including machinery.

Mich., Muskegon — Brunswick-Balke-Collender Co., Muskegon, manufacturer of bowling alleys, billiard tables, etc., will build new one-story aircraft assembling plant at Muskegon County Airport, for production of light-type airplanes for Government. Electric power equipment will be installed. Cost reported over $400,000, with machinery. Financing will be provided by Defense Plant Corp., Washington, D. C., Federal agency.

Minn., St. Paul—Swift & Co., Union Stock Yards, South St. Paul, meat packers, plan installation of electric power equipment in new two-story top addition, about 80x105 ft, to local plant,

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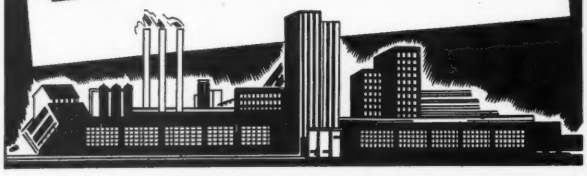

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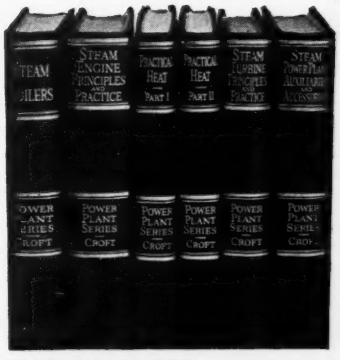
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for which superstructure will begin soon. Cost reported over $85,000, with machinery. Main offices are in Union Stock Yards, Chicago, Ill. Company engineering department is in charge, last noted address.

N. J., Paulsboro—Socony-Vacuum Oil Co., Billingsport Ave., plans installation of power equipment, steel storage tanks, piping and other facilities in connection with expansion in local oil refinery for increased gasoline production. Cost estimated about $1,250,000. Output will be used by Government, which will provide financing through Defense Plant Corp., Washington, D. C., Federal agency, in amount noted. Main offices of company are at 26 Broadway, New York, N. Y.

N. J., Trenton—John A. Roebling's Sons Co., 640 South Broad St., manufacturer of wire rope, cable, etc., plans installation of electric power equipment in connection with expansion in plant for production for Government. Cost estimated about $100,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Work is scheduled to be carried out soon.

N. D., Linton—Board of Education, Linton Special School District, plans installation of new boiler, stoker and auxiliary equipment in central heating plant at school. No estimate of cost announced.

Ohio, Akron — Goodyear Aircraft Corp., Akron, an interest of Goodyear Tire & Rubber Co., same place, will carry out expansion in plant for production for Government. New buildings will be erected, with installation of machinery and electric power equipment for increased capacity. Cost estimated about $2,500,000. Company will carry out a similar program for expansion in branch plant at Phoenix, Ariz., to cost approximately $2,450,000. Financing in both cases will be furnished by Defense Plant Corp., Washington, D. C., Federal agency. Work is scheduled to begin soon.

Ohio, Painesville — Diamond Alkali Co., Oliver Building, Pittsburgh, Pa., manufacturer of alkali products, industrial chemical specialties, etc., plans installation of electric power equipment in connection with expansion in plant at Painesville for production for Government. Several new additions will be built, with machinery installation for large increased capacity. Cost estimated close to $1,000,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, is engineer.

Ohio, Toledo — Sinclair Refining Co., 1435 Miami St., oil and gasoline products, plans pumping plant in connection with proposed new bulk oil storage and distributing plant on waterfront, where docks, warehouses and other structures will be built. Also will install a number of steel storage tanks, pipe lines and other facilities. Entire project is estimated to cost about $1,000,000. Main offices are at 630 Fifth Ave., New York, N. Y.

Ore., Hillsboro—Washington County Flax Growers, Inc., Hillsboro, recently organized, plans boiler house in connection with new flax processing plant on local site for production for Government. It will comprise several one-story buildings, with facilities for large output. Power equipment will be installed. Cost estimated about $180,000, with financing to be provided by Defense Plant Corp., Washington, D. C., Federal agency. East Side Commercial Club, Worth W. Caldwell, president, is interested in project.

Ore., Portland—Northwestern Ice & Cold Storage Co., 73 S. E. Washington St., has completed plans for new one-story plant, 100x200 ft, at S. E. Washington and Water Sts., and will begin work at once. Output will be used by Government. Cost estimated about $200,000, with equipment, financing to be provided by Defense Plant Corp., Washington, D. C., Federal agency.

Texas, Jasper—Jasper-Newton Electric Co-operative, Inc., Jasper, E. T. Ahlman, president, plans electric power plant for service for new electrical distribution system to be constructed in parts of Jasper and Newton Counties. Fund of $185,000 has been secured through Federal aid and work will be placed under way soon.

Wyo., Evanston — Stanolind Pipe Line Co., Evanston, plans construction of a new pumping station for booster service for oil pipe line operation. Also new one-story mechanical shop and miscellaneous structures. Cost reported over $75,000. Company is affiliated with Stanolind Oil & Gas Co., Tulsa, Okla.

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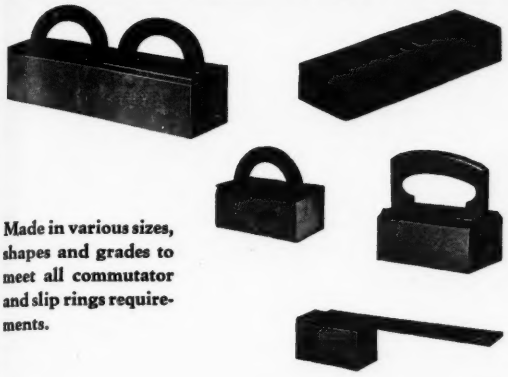

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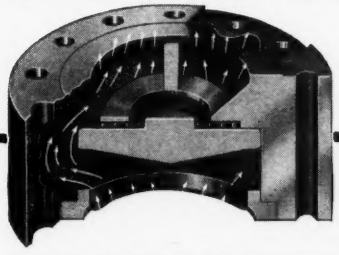

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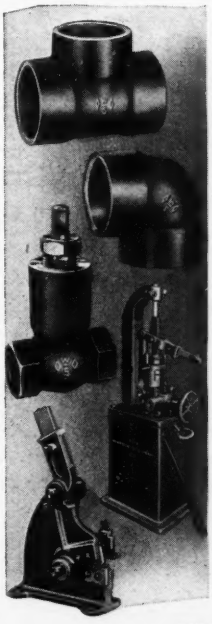

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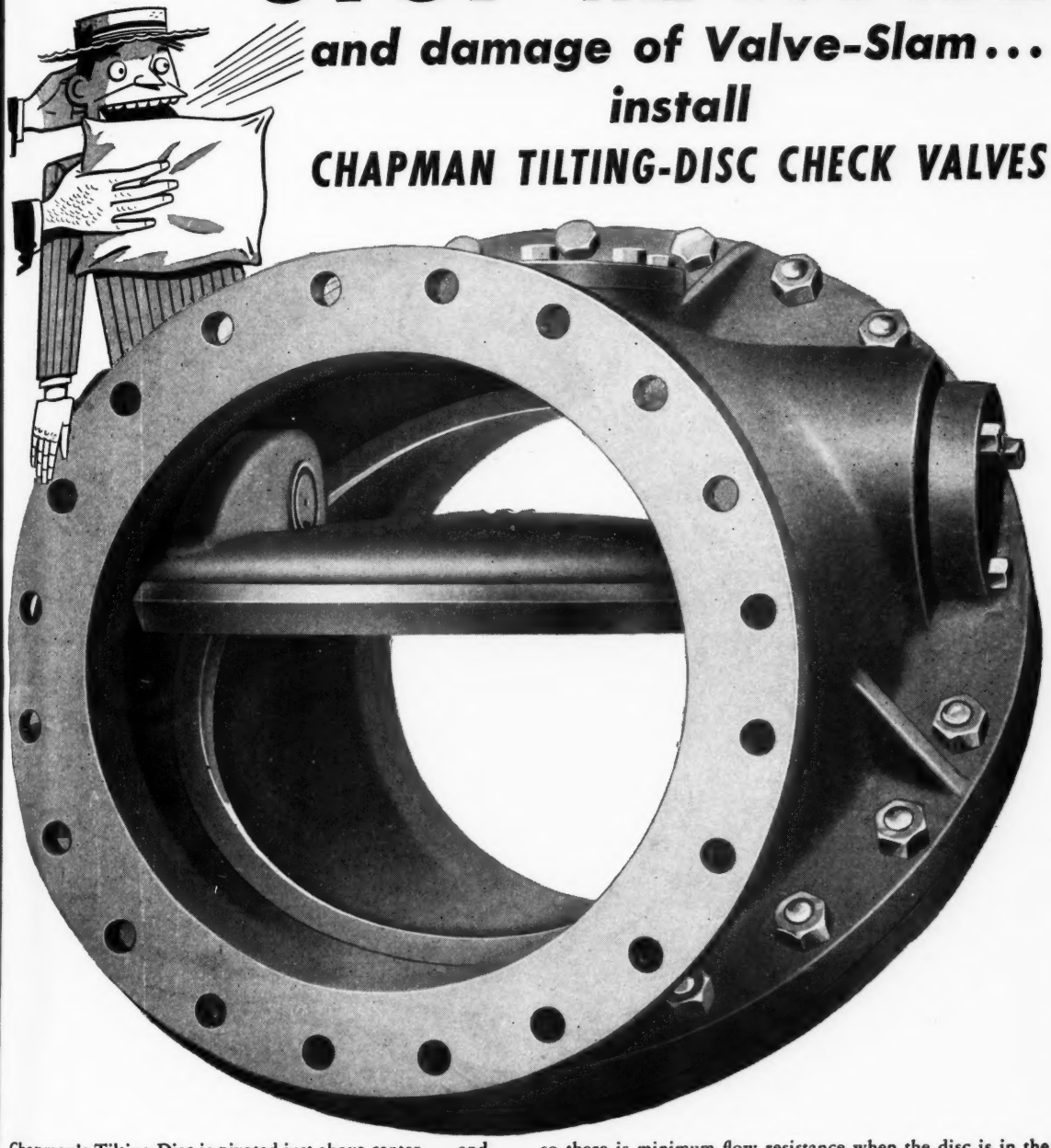

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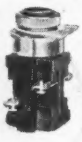

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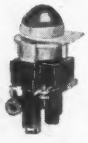

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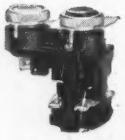

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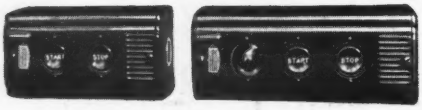

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